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AGARD

ADVISORY GROUP FOR AEROSPACE RESEARCH & DEVELOPMENT

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A Research Agenda for Scientific and Technical Information

(Un Programme de Recherche pour
l'Information Scientifique et Technique)

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*Report of a Workshop held in Lisbon, Portugal, on 7th—9th April, 1992,
by the Technical Information Panel of AGARD.*

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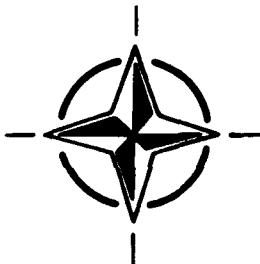7 RUE ANCELLE 92200 NEUILLY SUR SEINE FRANCE

AGARD ADVISORY REPORT 316

A Research Agenda for Scientific and Technical Information

(Un Programme de Recherche pour
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by the Technical Information Panel of AGARD.

North Atlantic Treaty Organization
Organisation du Traité de l'Atlantique Nord

The Mission of AGARD

According to its Charter, the mission of AGARD is to bring together the leading personalities of the NATO nations in the fields of science and technology relating to aerospace for the following purposes:

— Recommending effective ways for the member nations to use their research and development capabilities for the common benefit of the NATO community;

— Providing scientific and technical advice and assistance to the Military Committee in the field of aerospace research and development (with particular regard to its military application);

— Continuously stimulating advances in the aerospace sciences relevant to strengthening the common defence posture;

— Improving the co-operation among member nations in aerospace research and development:

— Exchange of scientific and technical information;

— Providing assistance to member nations for the purpose of increasing their scientific and technical potential:

— Rendering scientific and technical assistance, as requested, to other NATO bodies and to member nations in connection with research and development problems in the aerospace field.

The highest authority within AGARD is the National Delegates Board consisting of officially appointed senior representatives from each member nation. The mission of AGARD is carried out through the Panels which are composed of experts appointed by the National Delegates, the Consultant and Exchange Programme and the Aerospace Applications Studies Programme. The results of AGARD work are reported to the member nations and the NATO Authorities through the AGARD series of publications of which this is one.

Participation in AGARD activities is by invitation only and is normally limited to citizens of the NATO nations.

Abstract

This Report presents the results of a workshop held by the Technical Information Panel of AGARD on 7th—9th April 1992 in Lisbon, Portugal.

It includes three position papers on user needs, information access, and the organisation and transfer of information, prepared by the authors as a result of the discussions at the workshop. The outcome of the workshop, in the form of a 53-item research agenda, is given under the headings: information management; provision of information; and access to information. Each is examined from the aspects of human resources, quality assurance, cost, and technology, where appropriate.

The Report also includes a list of 15 additional areas meriting further investigation, which were identified by participants, during the final session of the workshop.

Résumé

Ce rapport rend compte des résultats d'un atelier organisé par le Panel AGARD de l'Information Technique, du 7 au 9 avril 1992 à Lisbonne, au Portugal.

Il inclut trois sommaires sur les besoins des utilisateurs, l'accès aux informations et l'organisation et le transfert des données, élaborés suite aux discussions qui ont eu lieu lors de l'atelier. Les conclusions de la réunion, sous la forme d'un programme de recherche comprenant 53 points, sont présentées par domaine comme suit:

— la gestion de l'information
— l'apport des informations
— l'accès à l'information.

Chaque aspect est examiné du point de vue des ressources humaines, de l'assurance qualité, du coût et, éventuellement, des technologies employées.

Ce rapport comprend également une liste de 15 domaines additionnels qui mériteraient de plus amples recherches, et qui ont été identifiés par les participants lors de la dernière session de l'atelier.

Workshop Speakers

Prof. P. Hernon
Graduate School of Librarianship
and Information Science
Simmons College
300 The Fenway
Boston MA 02115
United States

Dr T.E. Pinelli
Research Information
and Applications Division
NASA Langley Research Center
Hampton VA 23665-5225
United States

Dr W. Tuck
Department of Computer Science
University College
Gower Street
London WC1E 6BT
United Kingdom

Workshop Convener

Mr W.R. Blados
NASA Scientific and Technical
Information Office
Washington DC 20546
United States

Technical Information Panel

Chairman: Mr Albert Yanez
Conseiller du Directeur
C.E.D.O.C.A.R.
00460 Armées
France

Deputy Chairman: Ms Gladys Cotter
Director
NASA Scientific and Technical
    Information Program
NASA Headquarters
Washington DC 20546
United States

RESEARCH AGENDA SUB-COMMITTEE

Director: Dr A.M.R. Correia   (PO)

Vice-Director: Dr J.M. Hughes   (US)

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Mrs R. Gjersvik   (NO)
Mr M.R.C. Wilkinson (UK)
Mr R.P. Ryan   (US)

PANEL EXECUTIVE

Mr G.W. Hart

Mail from Europe:
AGARD—OTAN
Attn: TIP Executive
7, rue Ancelle
92200 Neuilly-sur-Seine
France

Mail from US and Canada:
AGARD—NATO/TIP
Unit 21551
APO AE 09777

Tel: 33(1)47 38 57 95
Telex: 610176 (France)
Telefax: 33 (1) 47 38 57 99

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INTRODUCTION

TOWARD A RESEARCH AGENDA FOR SCIENTIFIC AND TECHNICAL INFORMATION (STI)

Walter R. Blados
NASA Scientific and Technical Information Office
Washington, DC
U.S.A.

Past research on information users and nonusers, information needs, information access, and information organization and management has tended to be noncumulative, repetitive, descriptive, and lacking in generalization and in the use of inferential statistics. Other striking characteristics of past research are that it often depicts a particular point in time, does not disclose trends over time, relies solely on one means of data collection (generally a self-reporting survey), and varies greatly in quality. Much of the research is neither comparative nor cross cultural.

An acquired body of research is vital to the development of theory and the solution of professional problems; to the formation of tools and methods for analyzing organizations, services, environments, and behaviors; for determining the cost and benefits of information products, services, and systems; for establishing and developing theories upon which to base practice; and for contributing paradigms, models, and radically new conceptualizations of library and information science phenomena.

On 7–9 April, the NATO Advisory Group for Aerospace Research and Development (AGARD) Technical Information Panel (TIP) conducted a workshop in Lisbon, Portugal, to develop a research agenda on issues related to scientific and technical information (STI) management (funding, production, collection, organization, and transfer of STI) and policy (legislation, organizational practices, decisions).

In developing this research agenda, the TIP desired not only to identify key developments and issues within information science programs to make information specialists more cognizant of current realities, but to make recommendations for further research and study in order to:

- better understand problems and issues not fully understood or resolved; and/or

- examine the effectiveness or efficiency of a program, service, or activity.

The AGARD TIP Research Agenda Subcommittee selected three broad categories which were of interest to the nations; namely:

- User and Usage Studies to examine user needs issues, to address information economy as well as diffusion of knowledge.

- Information Access to examine user awareness issues to address the availability and use of scientific and technical information as well as identifying and locating information sources.

- Organization and Transfer of Information to examine information transfer issues to address reduction of barriers in retrieval and transfer of scientific and technical information as well as ensuring quality and information integrity.

Dr. Thomas Pinelli, Langley Research Center, chaired the User and Usage Studies workshop session. Dr. Peter Hernon, Professor, Simmons College, chaired the Information Access workshop session; and Dr. Bill

Tuck, Professor, University College London, chaired the Organization and Transfer of Information workshop session.

The Workshop began in a plenary session, during which each of the Chairmen presented a white paper on the particular aspect for which he was tasked. Workshop participants were then divided into three groups, to discuss the three categories of interest, and develop and establish an agenda for which R&D is essential.

The three papers, included in this report as Chapters 2, 3, and 4, have incorporated the thrusts and results of the workshop discussions. Chapter 5, titled The AGARD TIP Research Agenda for Scientific and Technical Information (STI), is a synthesis of the Workshop. Chapter 6 contains additional topic areas meriting investigation; this is based on what each workshop attendee considered to be the single, most important research topic.

The TIP considered this workshop to be of extreme importance, not only because it evoked and represented responses at individual, organizational, national and international levels, but because it will also provide an international agenda for research in STI issues, which, in turn, will enhance aerospace and defense research and development through more effective management, dissemination, and use of scientific and technical information. It will provide a basis from which to select and initiate systematic studies of areas of specific opportunities for improving access to and utilization of scientific and technical information. This agenda will stimulate thinking about the role of research and the opportunities for the conduct of research. It will also provide ideas, approaches, and strategies that can assist the advancement of the information profession or discipline, and improve the overall quality, quantity, and impact of that research.

Clearly, as shown in the three papers and the discussion at the AGARD TIP workshop, there is a need for research as well as numerous opportunities to conduct and report research, be it theoretical or practical, or quantitative or qualitative. The research might extend or examine theoretical frameworks, or engage in model construction and testing. Models illustrate a set of theoretical relationships mathematically or graphically, and are subject to empirical research.

The theoretical frameworks and models developed for the general public and other groups might be applied to scientists and engineers, and might recognize that individuals might assume different roles within work and non-work related situations. It might be useful to disrupt these models by exploring the impact of new variables, such as declining readability levels of the general public and declining language and writing skills, on information-seeking behavior.

The topical areas and research questions identified in various sections of the report can be explored using various research designs and methodologies. These might be studies employing the necessary controls (reliability and validity), policy analyses, evaluation research examining the effectiveness and efficiency of information services,

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programs and operations. Instead, of relying so much on testimonials and supposition, information managers can use decision research and valuation research to improve decision making. There might also be historical research linking the past to the present and the future, and descriptive studies not limited to the use of self-reporting methods of data collection.

The above-mentioned approaches suggest that data collection should not be confined to survey research. There are opportunities to use methodologies, such as transactional analysis, unobtrusive and obtrusive testing, standardized tests, bibliometrics (including citation analysis), participant observation, and focus group interviews.

The consensus of the conference participants was that it is absolutely necessary to explore the information needs and information-seeking behavior of users and nonusers. Instead of treating, nonusers as a single group, researchers might adopt conceptual frameworks from marketing and identify target audiences, perhaps those non users most likely to modify their present information-seeking behavior.

For years, research focused more on users than uses. Studies should "focus on what people do, or wish they could do if they could just figure out how to get the necessary information" (White, 1980, p. 683). Instead of focusing on the use or nonuse of an information provider, such as a library or information center, research should frame that use or nonuse within a larger context: where do scientists, engineers, or others turn when they need information? Do they turn to interpersonal sources, institutional sources, or the mass or electronic media? Which sources do they use and which ones of they avoid, and why? How satisfied are they with a particular information provider? These and other questions underscore that there is still a significant amount of research to conduct and re-

port relating to STI users and uses. Again, such research must have value to decision makers and policy makers. As a consequence, there is need for more decision, policy and evaluation research.

Within the framework set by Dr. Pinelli, research might examine human resources, quality assurance, cost, or technology. These areas are not mutually exclusive. Studies might probe one or more of these areas simultaneously.

In sum, this report has identified areas where significant research might be conducted and reported. There are enormous opportunities, but, to repeat, that research must have decision, evaluation, and policy implications.

Where do we go from here?

Conference participants found the decision of a research agenda stimulating and needed. They recognized that AGARD had made an important first step and want to build from this modest beginning. One method for doing so would be to develop white papers or review essays on topics such as the value of information, information as a commodity, performance measures, and user/staff education and training. These essays should draw upon an international literature produced in different disciplines. Furthermore, the essays should be analytical and encourage the conduct of research.

There is a great deal of work that needs to be done, and time and patience will be required to initiate and conduct the many facets that have been proffered.

References

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ESTABLISHING A RESEARCH AGENDA
FOR SCIENTIFIC AND TECHNICAL INFORMATION (STI):
FOCUS ON THE USER

Thomas E. Pinelli, Ph.D.
NASA Langley Research Center
Hampton, Virginia 23665
U.S.A.

Introduction

A body of knowledge derived from systematic inquiry is a prerequisite for any endeavor to gain acceptance as a scholarly field of inquiry. Good solid research advances the state of the art by contributing to the body of knowledge that, in turn, may be applied to solve the numerous problems faced each day by practitioners. Robert Smith (1984) points out that "[R]esearch and scholarship are the lifeblood of any profession that seeks to gain acceptance as a discipline. The members of that profession, at one time or another, will either be producers or consumers of research or both." He distinguishes between "research" and "scholarship," a distinction that can be very useful when establishing a research agenda for STI. Research is the "discovery of new knowledge" while scholarship is the "organization, criticism, and interpretation of facts and concepts" (Smith, 1984). According to Molly Stock (1985), both can lead to greater understanding and the extension of "traditions, authority, intuition, and the generation of new ideas."

Background

Library and information science, as a collective entity, is the endeavor most closely associated or identified with the provision of STI. However, when the production, transfer, and use of STI are considered, the envelope expands to include such widely diverse endeavors as computer science, communications, psychology, and technical communications. Library science and information science have been variously debated in terms of definition, content, status as a discipline, and quality of research and scholarship. The essential point is, perhaps, overlooked in such debates. A body of knowledge derived from research is the key to attaining acceptance as a discipline. Once this general body of knowledge has been developed, substantive research questions can be generated and systematically tested. The results of these tests are made available (published) and subjected to scholarship for review and evaluation so that the merit(s) of these findings can be judged. Each investigation contributes to the expansion of the overall knowledge of the discipline. The cumulative effort of this gradual process leads to verification: spurious information is identified and replaced by more accurate information.

The Concept of Research

At a basic or general level, the concept of research is fairly well understood. It is generally accepted that research implies the application of the scientific method. As Caudra (1982) points out, "most definitions of research contain two components: the methodology component, which includes the collection and analysis of data; and the purpose component, which includes the formulation, revision, and the rejection of hypotheses and conclusions based on the analyses of these data." Library science and information science research have been variously criticized for failing to meet the standards of "scientific inquiry" in both these areas.

The most frequent criticisms focus on the first component. Much of the early library science and information research was not conducted using the scientific method.

While improvements have occurred over time, problems with methodology and purpose still exist. Perhaps even more critical are the alleged shortcomings in the second component. Numerous writers, such as Busha (1981), fault library science and information science for not asking the "right" questions or establishing a theoretical foundation for further research and application. Ennis (1967) commented that library science research is "noncumulative, fragmentary, generally weak, and relentlessly oriented to immediate practice." Rohde (1986) concurs stating that the "difficulty in applying the findings reported in the literature has been attributed to the lack of a unifying theory, standardized methodology, and common definitions." From the standpoint of the user, Holland (1991) and her colleagues concluded that "the literature regarding the information-seeking behavior of engineers is fragmented and superficial and the results of these [user] studies have not accumulated to form a significant body of knowledge that can be used by information professionals."

Linking Theory With Practice

What is or should be the relationship between library science and information science theory and practice, between the development of conceptual understanding, and the practical competence of information professionals? To elaborate on this point, a provocative note by Carl Keren (1984) appeared in the March issue of the *Journal of the American Society for Information Science (JASIS)* under the title "On Information Science." Keren raises interesting questions about the relationship between information science research and practice. Keren asks four questions (slightly paraphrased):

1. Do researchers in information science write about research that advances the state of the art?

2. How much of the research output has really contributed to our body of knowledge?

3. Is information science a name with a recognizable body attached to it? Is it a subject whose contents we can define?

4. Is there a lack of feedback between researchers and practitioners?

Gerald Salton's (1985) response appeared in the July issue of *JASIS* under the title "A Note About Information Science Research." Salton states that questions such as these "are, of course, not new, and they are reflective of legitimate concerns." Salton further states, generally agreeing with Keren, that "most of the published research in our field is probably not worth doing and ought to be forgotten." He further states that, on the other hand, "not all information science research is inferior and that [in general] not all information science research is useless." As evidence, Salton cites a number of topics which have been actively researched in information science. These include the vector processing retrieval strategy, probabilistic retrieval models, best match retrieval, query reformulation using relevance feedback, refinements of Boolean searching using term weights, and improved front-ends and expert system designs.

Concluding his response, Salton contends that, "as is the case in all other intellectual areas of endeavor, there are never any shortcuts in bridging the gap between research and practice (application)." It is necessary to *study* the literature; it is necessary to have sufficient know-how to discriminate and to put matters in context. Eventually the pieces will fit together, and the observer can judge the specifics instead of being forced to rely on superficial impressions and generalizations. Maybe Salton's final comment is the most telling. "Perhaps [library science and information science] would evolve even more rapidly if the practitioners would stop blaming the research side and asked instead 'What have we practitioners done for ourselves lately.'"

The Reality of Theory Based Practice

In March 1989, a symposium titled "Organizing a Research Agenda: Information Studies for the 1990s" was held at Dalhousie University in Halifax, Nova Scotia. In a paper delivered at this symposium, Edie Rasmussen (1989) responds to Salton's (1985) "A Note About Information Science Research" by stating that many of the procedures listed by Salton (1985) could be implemented directly in existing information retrieval (IR) systems, though, in fact, few have been. Thus, it would appear that very few research findings in IR have found their way into readily available IR systems. As Rasmussen (1989) insists "[I]t seems, therefore, that IR research has contributed considerably to knowledge but very little to practice, an outcome that has recently been recognized as a problem by researchers themselves." Rasmussen's sentiment is also echoed by Radecki (1988) who wrote:

> Despite the fact that considerable progress has been made in information retrieval research, particularly in the last decade or so, it has hardly affected commercial retrieval systems, which, as a rule, are founded on conventional Boolean logic (p. 219).

The reality is simple. In library and information science, theory has little to do with practice. Further, little relationship, if any, exists between the development of library science and information science theory and change in the practice of library and information science. To further develop this point, it is important to differentiate between changes due to new technologies and changes resulting from theoretical-based research (Rasmussen, 1989). The major changes that have occurred in libraries and technical information centers in the past 25 years are due more to advances in information technology than to advances in library science and information science research. While technology has altered *how* information professionals perform their tasks, it has done little to influence the *structure* or *nature* of those tasks (Molholt, 1987).

Why the Disconnect?

There are several views on this point. One perspective holds that in library science and information science there is too little interaction between the communities of researchers (e.g., schools of library and information science) and practitioners (e.g., librarians and technical information specialists). Specifically, there is far too little interaction between the academic community, where the bulk of the researchers abide, and the environment in which the provision of information takes place; the world in which the practitioners reside. Further, very few mechanisms exist for the transfer of information between the two worlds. Researchers publish their results in scholarly, not "trade" journals. Publication in "learned" journals is required for tenure and promotion. Though some might consider this a "sweeping and indefensible generalization," practitioners, if they peruse the literature

at all, seldom read yet alone understand the articles appearing in such scholarly publications as *JASIS*.

Another perspective holds that professional schools, such as schools of library and information science and professional education (e.g., the preparation of librarians and technical information specialists), have no place in the university. The roots of this position, a position favoring non-occupational education, can be traced to English and German models of higher education. These are the models upon which U.S. colleges and universities are based. Although professional education programs have been added to the curriculums of many U.S. colleges and universities in recent years, these programs are frequently denigrated by the so-called "liberal arts." With the full expectation of gaining acceptance on the basis of scholarship, the members of the professional schools try to act and appear scholarly. This results in research that is more basic than applied and more theoretical and less practical and produces results that are simply not relevant to practitioners who constitute the bulk of the profession.

Another perspective holds that the "pull" of technology capability rather than the "push" of supporting theory has the greatest influence on the provision of information. The rapid pace of developments in four areas—communications, data storage, computing power, and computing cost—is leading the change in the information industry. Developments in these areas have combined to bring about the following trends: decentralization; larger and more varied data bases; a move from bibliographic to full text systems; an emphasis on document delivery rather than mere citation retrieval; and a proliferation of interfaces, especially those for end user searching (Rasmussen, 1989). None of these trends, however, involve any innovation or substantive change in the existing IR model which is essentially the same model developed in the late 1960s.

To expand on this point, Smit and Kocken (1988) undertook a survey to determine the impediments to innovation on the part of online data base vendors. Their research focused on how vendors made decisions to improve IR software. In addition, decisions on three particular innovations—ranking items in a search output in order of priority to the user, system-user adaption mechanisms, and menu-driven retrieval—which would be relatively easy to implement were examined. Perhaps more important than the answers given was the lack of knowledge about potential innovations amongst those responsible for the IR system. This lack of awareness lead Smit and Kocken to conclude that "online vendors differ from most high technology industries, where news about innovations is pursued with much dedication" (p. 283).

Finally, there is another perspective that views the user as the center of all information activities. Holders of this perspective believe that the needs of the user and the user's interaction with the information system were virtually ignored during the formative years of library science and information science research. Allen (1977) uses the following quote, attributed to Saul Herner (1954), to illustrate the importance of this perspective:

> Perhaps the most important and least considered factor in the design of information storage and retrieval systems is the user of such systems. Regardless of what other parameters are considered in the development of a storage and retrieval mechanism, it is necessary to consider its potential use and mode of use by the persons or groups for whom it is intended. It is necessary to either fashion the system to suit the user's needs, habits, and preferences, or to fashion the user to meet the needs, habits, and preferences of the system. Both approaches are possible but the second

one, involving education and reeducation of the user, is evolutionary and futuristic. A system designed for now should at least be able to serve the present user.

The Need for Research and Research Priorities

There are compelling reasons for conducting experimental, policy, and theoretical oriented STI research. First, STI is an essential ingredient of research and development (R&D). The ability of engineers and scientists to identify, acquire, and utilize STI is of paramount importance to the efficiency of the R&D process. Testimony to the central role of STI in the R&D process is found in numerous studies (Fischer, 1980). These studies show, among other things, that engineers and scientists devote more time, on the average, to the communication of technical information than to any other scientific or technical activity (Pinelli, et al., 1989). A number of studies have found strong relationships between the communication of STI and technical performance at both the individual (Allen, 1970; Hall and Ritchie, 1975; and Rothwell and Robertson, 1973) and group levels (Carter and Williams, 1957; Rubenstein, et al., 1971; and Smith, 1970).

These findings support the conclusion that the role of scientific and technical communication is thus central to the success of the innovation process, in general, and the management of R&D activities, in particular. But there in lies the problem. While STI is crucial to successful R&D, linkages between the various sectors of the R&D infrastructure are weak and/or poorly defined. It is likely that an understanding of the process by which STI is communicated through certain channels over time among the members of the social system would contribute to increasing productivity, stimulating innovation, and improving and maintaining the professional competence of engineers and scientists.

Second, despite the vast amount of STI available to potential users, several major barriers to effective utilization exist. The very low level of support for STI transfer and use in comparison to STI production suggests that dissemination efforts are not viewed as an important component of the R&D process. There are mounting reports from users about difficulties in getting appropriate STI in forms useful for problem solving and decision making. Rapid advances in many areas of science and technology can be fully exploited only if they are quickly translated into further research and application. Current mechanisms are often inadequate to help users assess the quality of available information. The characteristics of actual usage behavior are not sufficiently taken into account in making available useful and easily retrieved STI.

Third, while various approaches have been tried, STI transfer activities continue to be driven by a "supply-side" dissemination model. The dissemination model emphasizes the need to transfer information to potential users and embraces the belief that the production of quality knowledge is not sufficient to ensure its fullest use. Linkage mechanisms, such as information intermediaries, are needed to identify useful knowledge and to transfer it to potential users. This model assumes that if these mechanisms are available to link potential users with knowledge producers, then better opportunities exist for users to determine what knowledge is available, acquire it, and apply it to their needs. The strength of this model rests with the recognition that STI transfer and use are critical elements of the process of technological innovation. Its weakness lies with the fact that it is passive, for it does not take users into consideration except when they enter the system and request assistance; however, user requirements are seldom known or considered in the design of information products and services. This model employs one-way, source-to-user transfer procedures that are seldom responsive in the user context.

In the U.S., the existing STI dissemination transfer mechanism is composed of two parts—the informal that relies on collegial contacts and the formal that relies on surrogates, information products, and information intermediaries to complete the "producer to user" transfer process. The producers are the Federal R&D "mission" agencies and their contractors and grantees. Producers depend upon surrogates and information intermediaries to operate the formal transfer component.

Surrogates serve as technical report repositories or clearinghouses for the producers and include the Defense Technical Information Center (DTIC), the NASA Center for AeroSpace Information (CASI), and the National Technical Information Service (NTIS). Information intermediaries are, in large part, librarians and technical information specialists in academia, government, and industry. Those representing the producers serve as what McGowan and Loveless (1981) call "knowledge brokers" or "linking agents." Information intermediaries connected with users act, according to Allen (1977), as "technological entrepreneurs" or "gatekeepers." The more "active" the intermediary, the more effective the transfer process (Goldhor and Lund, 1983). Active intermediaries take information from one place and move it to another, often face-to-face. Passive information intermediaries, on the other hand, "simply array information for the taking, relying on the initiative of the user to request or search out the information that may be needed" (Eveland, 1987, p. 4).

The major problem with the total STI system is "that the present system for transferring the results of government funded STI is passive, fragmented, and unfocused." Effective knowledge transfer is hindered by the fact the U.S. government "has no coherent or systematically designed approach to transferring the results of government funded R&D to the user" (Ballard, et al., 1986, pp. 2-3). Approaches to STI transfer vary considerably from agency to agency and, with any given agency, have changed significantly over time. These variations reflect differences between agencies (i.e., legislative mandates), the interpretation of their missions, and budgetary opportunities and constraints. In their study of issues and options in U.S. government funded STI, Bikson and her colleagues (Bikson, Quint, and Johnson, 1984) found that many interviewees considered dissemination activities "afterthoughts, undertaken without serious commitment by U.S. government agencies whose primary concerns were with [knowledge] production and not with knowledge transfer;" therefore, "much of what has been learned about knowledge transfer has not been incorporated into U.S. government supported STI transfer activities" (p. 22).

The specific problem with the informal part of the system is that knowledge users can learn from collegial contacts only what those contacts happen to know. Ample evidence supports the claim that researchers can know about or keep up with all the research in their area(s) of interest. Two problems exist with the formal part of the system. First, it employs one-way, source-to-user transmission. However, one-way, "supply-side" transfer procedures do not seem to be responsive to the user context (Bikson, Quint, and Johnson, 1984). Rather, these efforts appear to start with an information system into which the users' requirements are retrofit (Adam, 1975). The consensus of the findings from the empirical research is that interactive, two-way communications are required for effective information transfer. (Bikson, Quint, and Johnson, 1984).

Second, the formal part relies heavily on information intermediaries to complete the knowledge transfer process, but a strong methodological base for measuring or assessing the effectiveness of the information intermediary is lacking (Kitchen and Associates, 1989). The impact of information intermediaries is likely to be strongly conditional and limited to a specific institutional context. To date, empirical findings on the effectiveness of information intermediaries and the role(s) they play in knowledge transfer are sparse and inconclusive (Beyer and Trice, 1982).

The formal part of the transfer mechanism is particularly ineffective because STI is not organized and structured according to problem relevance. More to the point, putting STI to use frequently requires transferring it in a use context that is quite different from the context in which it was produced or originally packaged. This problem is complicated by the fact that STI is organized along traditional disciplinary lines as are subject matter indexes, abstracts, and key words. This organizational scheme makes multidisciplinary retrieval extremely difficult for users and (typically non-technical) information intermediaries alike. The formal part of the transfer mechanism becomes even less effective when the user's environment is not well aligned with the standard disciplinary taxonomies (Bikson, Quint, and Johnson, 1984).

Fourth, although considerable research into technological innovation and policy analysis has been conducted by various disciplines and from numerous perspectives, policy implications from the results of this research and investigation are inconsistent, contradictory, and are simply not used for policy development. Moreover, there is a general consensus that current conceptual and empirical knowledge regarding both the process of technological innovation and government intervention is lacking. According to Curlee and Goel (1989), recognition is growing that technology transfer and diffusion is the "key" to the success of technological innovation. Consequently, understanding the factors that motivate innovation and channel its direction is necessary if intervention is to successfully increase the production of useful innovation. Nelson (1982) and Pavitt and Walker (1976), in separate reviews and analyses of government policies and programs toward technological innovation, state that government innovation policy and prescription encourage innovation, not its adoption; knowledge transfer and utilization [diffusion] are "very inadequately served by market forces and the incentives of the market place." They conclude government would better serve technology policy by assuming a more active role in the knowledge diffusion process and by formulating policies and programs that encourage and improve communications between users and producers of knowledge. However, it is obvious many of the industrialized nations lack a systematically designed approach to transferring the results of government funded R&D to the user (Ballard, 1986). Although U.S. technology policy efforts rely on a "dissemination-oriented" approach to STI transfer, other industrialized nations, such as Germany and Japan, are adopting "diffusion-oriented" policies which increase the power to absorb and employ new technologies productively.

The knowledge diffusion model is grounded in theory and practice associated with the diffusion of innovation and planned change research and the clinical models of social research and mental health. Knowledge diffusion emphasizes "active" intervention as opposed to dissemination and access; stresses intervention and reliance on interpersonal communications as a means of identifying and removing interpersonal barriers between users and producers; and assumes that knowledge production, transfer, and use are equally important components of the R&D process. This approach also emphasizes the link between producers, transfer agents, and users and seeks

to develop user-oriented mechanisms (e.g., products and services) specifically tailored to the needs and circumstances of the user. It makes the assumption that the results of government funded R&D will be under utilized unless they are relevant to users and ongoing relationships are developed among users and producers. The problem with the knowledge diffusion model is that (1) it requires a large government role and presence and (2) it runs contrary to the dominant assumptions of the established "supply-side" R&D policy system.

Compelling reasons also exist for establishing STI research priorities. Shaughnessy (1976) noted some previous attempts in this article, "Library Research in the 70's: Problems and Prospects." He cites as examples Frank Schick's (1963) essay "Library Science Research Needs," Ralph Blasingame's (1965) contribution, "Some Research Questions," and Harold Borko's (1973) delphi study. Shaughnessy concluded that the main problem confronting the profession was not the absence of research priorities but, rather, how to communicate the results of research to practitioners in the field in a meaningful way. More recent attempts include the work undertaken by Cuadra Associates, Inc. (1982) entitled *A Library and Information Science Research Agenda for the 1980's*; the work by Griffiths and King (1985) entitled, *New Directions in Library and Information Science Education*; and Jane Robbins' (1987) article, "Another! Research Agenda." The more recent contributions include, *Rethinking the Library in the Information Age*, sponsored by the U.S. Department of Education (1988), a symposium at Dalhousie University (1989), and McClure and Hernon's (1991) book, *Library and Information Science Research: Perspectives and Strategies for Improvement*.

Focus on the User and Information-Seeking Behavior

There are many different information user communities. The differences between them may be great. Even within similar or related user communities there may be considerable differences among users. Thus, to meet the information needs of the user communities, information professionals must first understand the nature of the user community and become familiar with the information-seeking behavior of the user. For purposes of this paper, the users are aerospace engineers and scientists and the user community is aerospace.

Numerous studies concerned with information users and information-seeking behavior have been conducted. The general consensus is that this research is noncumulative, fragmentary, and generally weak. All and all, the literature regarding information-seeking behavior is fragmented and superficial. The results of these [user] studies have not accumulated to form a significant body of knowledge that can be used to develop practice based theory and information systems and services.

Part of the problem is definition. The two communities (engineering and science) and user groups (engineers and scientists) are not the same and the argument ... ... scientist is a more generic term merely evades the fundamental issue. The practice of lumping the two groups [engineers and scientists] together is self-defeating in information [production, transfer, and] use studies because confusion over the characteristics of the sample has led to what appears to be conflicting results and to a greater difficulty in developing normative measures for improving information systems in either science or technology.

Further, the terms engineer and scientist are not synonymous. The difference in work environment and personal/professional goals between the engineer and scientist proves to be an important factor in determining their information-seeking habits and practices.

Background

In their treatise, *The Positive Sum Strategy: Harnessing Technology for Economic Growth*, Landau and Rosenberg (1986) describe technological innovation as the critical factor in the long-term economic growth of modern industrial societies that functions successfully only within a larger social environment that provides an effective combination of incentives and complementary inputs into the innovation process. Technological innovation is a process in which the communication of STI is critical to the success of the enterprise (Fischer, 1980).

"Technology, unlike science, is an extroverted activity; it involves a search for workable solutions to problems. When it finds solutions that are workable and effective, it does not pursue the why? very hard. Moreover, the output of technology is a product, process, or service. Science, by contrast, is an introverted activity. It studies problems that are usually generated internally by logical discrepancies or internal inconsistencies or by anomalous observations that cannot be accounted for within the present intellectual framework" (Landau and Rosenberg, 1986). Technology is a process dominated by engineers, as opposed to scientists, which "leads to different philosophies and habits not only about contributing to the technical literature but also to using the technical literature and other sources of information" (Joenk, 1985). Consequently, an understanding of the relationship between science and technology and the information-seeking habits and practices of engineers is essential to the development and provision of information services for engineers.

The Nature of Science and Technology

The relationship between science and technology is often expressed as a continuous process or normal progression from basic research (science) through applied research (technology) to development (utilization). This relationship is based on the widely held assumption that technology grows out of or is dependent upon science for its development. However, the belief that technological change is somehow based on scientific advance has been challenged in recent years. Substantial evidence exists that refutes the relationship between science and technology.

Schmookler (1966) has attempted to show that the variation in inventive activity between different American industries is explicable in terms of the variation in demand, concluding that economic growth determines the rate of inventive activity rather than the reverse. Price (1965), in his investigation of citation patterns in both scientific and technical journals, found that scientific literature is cumulative and builds upon itself, whereas technical literature is not and does not build upon itself. Citations to previous work are fewer in technical journals and are often the author's own work.

Price (1965) concluded that science and technology progress independently of one another. Technology builds upon its own prior developments and advances in a manner independent of any link with the current scientific frontier and often without any necessity for an understanding of the basic science underlying it.

In summarizing the differences between science and technology, Price (1965) makes the following 12 points. **First**, science has a cumulating, close-knit structure; that is, new knowledge seems to flow from highly related and rather recent pieces of old knowledge, as displayed in the literature. **Second**, this property is what distinguishes science from technology and from humanistic scholarship. **Third**, this property accounts for many known social phenomena in science and also for its surefootedness and high rate of exponential growth. **Fourth**, technology shares with science the same high growth rate, but shows

quite complementary social phenomena, particularly in its attitude to the literature. **Fifth**, technology therefore may have a similar, cumulating, close-knit structure to that of science, but it is of the state of the art rather than of the literature. **Sixth**, science and technology each therefore have their own separate cumulating structures. **Seventh**, a direct flow from the research front of science to that of technology, or vice versa, occurs only in special and traumatic cases since the structures are separate.

Eighth, it is probable that research-front technology is strongly related only to that part of scientific knowledge that has been packed down as part of ambient learning and education, not to research-front science. **Ninth**, research-front science is similarly related only to the ambient technological knowledge of the previous generation of students, not to the research front of the technological state of the art and its innovation. **Tenth**, this reciprocal relation between science and technology, involving the research front of one and the accrued archive of the other, is nevertheless sufficient to keep the two in phase in their separate growths within each otherwise independent cumulation. **Eleventh**, it is therefore naive to regard technology as applied science or clinical practice as applied medical science. **Twelfth**, because of this, one should be aware of any claims that a particular scientific research is needed for particular technological breakthroughs, and vice versa. Both cumulations can only be supported for their own separate ends.

Allen (1977), who studied the transfer of technology and the dissemination of technological information in R&D organizations, finds little evidence to support the relationship between science and technology as a continuous relationship. Allen concludes that the relationship between science and technology is best described as a series of interactions that are based on need rather than on a normal progression.

Allen (1977) states that the independent nature of science and technology (S&T) and the different functions performed by engineers and scientists directly influence the flow of information in science and technology. Science and technology are ardent consumers of information. Both engineers and scientists require large quantities of information to perform their work. At this level, there is a strong similarity between the information input needs of engineers and scientists. However, the difference between engineers and scientists in terms of information processing becomes apparent upon examination of their outputs (Allen, 1977).

According to Allen (1977), information processing in S&T is depicted in the form of an input-output model. Scientists use information to produce information. From a system standpoint, the input and output, which are both verbal, are compatible. The output from one stage is in a form required for the next stage. Engineers use information to produce some physical change in the world. Engineers consume information, transform it, and produce a product that is information bearing; however, the information is no longer in verbal form. Whereas scientists consume and produce information in the form of human language, engineers transform information from a verbal format to a physically encoded form. Verbal information is produced only as a by-product to document the hardware and other physical products produced.

According to Allen (1977), there is an inherent compatibility between the inputs and outputs of the information-processing system of science. He further states that since both are in a verbal format, the output of one stage is in the format required for the next stage. The problem of supplying information to the scientist becomes a matter of collecting and organizing these outputs and making them accessible. Since science operates for

the most part on the premise of free and open access to information, the problem of collecting outputs is made easier.

In technology, however, there is an inherent incompatibility between inputs and outputs. Since outputs are usually in a form different from inputs, they usually cannot serve as inputs for the next stage. Further, the outputs are usually in two parts, one physically encoded and the other verbally encoded. The verbally encoded part usually cannot serve as input for the next stage because it is a by-product of the process and is itself incomplete (Allen, 1977). Those unacquainted with the development of the hardware or physical product therefore require some human intervention to supplement and interpret the information contained in the documentation. Since technology operates to a large extent on the premise of restricted access to information, the problem of collecting the documentation and obtaining the necessary human intervention becomes difficult (Allen, 1988).

Distinguishing Engineers From Scientists

In their study of the values and career orientation of engineering and science undergraduate students, Krulee and Nadler (1960) found that engineering and science students have certain aspirations in common: to better themselves and to achieve a higher socio-economic status than that of their parents. They reported that science students place a higher value on independence and on learning for its own sake while engineering students are more concerned with success and professional preparation. Many engineering students expect their families to be more important than their careers as a source of satisfaction, but the reverse pattern is more typical for science students.

Krulee and Nadler (1960) also determined that engineering students are less concerned than science students with what one does in a given position and more concerned with the certainty of the rewards to be obtained. They reported that, overall, engineering students place less emphasis on independence, career satisfaction, and the inherent interest their specialty holds for them and place more value on success, family life, and avoiding a low-level job. Engineering students appear to be prepared to sacrifice some of their independence and opportunities for innovation in order to realize their primary objectives. Engineering students are more willing to accept positions that will involve them in complex organizational responsibilities and they assume that success in such positions will depend upon practical knowledge, administrative ability, and human relation skills (Krulee and Nadler, 1960).

In his study of engineers in industry, Ritti (1971) found marked contrast between the work goals of engineers and scientists. Ritti draws the following three conclusions from his study: (1) the goals of engineers in industry are very much in line with meeting schedules, developing products that will be successful in the marketplace, and helping the company expand its activities; (2) while both engineers and scientists desire career development or advancement, for the engineer advancement is tied to activities within the organization, while advancement for the scientist is dependent upon the reputation established outside of the organization; and (3) while publication of results and professional autonomy are clearly valued goals of the Ph.D. scientist, they are clearly the least valued goals of the baccalaureate engineer.

Allen (1988) states that the type of person who is attracted to a career in engineering is fundamentally different from the type of person who pursues a career as a scientist. He writes that "perhaps the single most important difference between the two is the level of education. Engineers are generally educated to the baccalaureate level; some have a master's degree while some have

no college degree. The research scientist is usually assumed to have a doctorate. The long, complex process of academic socialization involved in obtaining the Ph.D. is bound to result in persons who differ considerably in their lifeviews." According to Allen (1988), these differences in values and attitudes toward work will almost certainly be reflected in the behavior of the individual, especially in their use and production of information.

According to Blade (1963), engineers and scientists differ in training, values, and methods of thought. Further, Blade states that the following differences exist in their individual creative processes and in their creative products: (1) scientists are concerned with discovering and explaining nature; engineers use and exploit nature; (2) scientists are searching for theories and principles; engineers seek to develop and make things; scientists are seeking a result for its own ends; engineers are engaged in solving a problem for the practical operating results; and (4) scientists create new unities of thought; engineers invent things and solve problems. Blade states that "this is a different order of creativity."

Finally, communication in engineering and science is fundamentally different. Communication patterns differ because of the fundamental differences between engineering and science and because of the social systems associated with the two disciplines. With one exception, the following characteristics of the social systems as they apply to the engineer and scientist are based on Holmfeld's (1970) investigation of the communication behavior of engineers and scientists.

Engineer

- Contribution is [technical] knowledge used to produce end-items or products.

- New and original knowledge is not a requirement.

- Reward is monetary or materialistic and serves as an inducement to continue to make further contributions to technical knowledge.

- Seeking rewards that are not part of the social system of technology is quite proper and also encouraged.

- The value of technical knowledge lies in its value as a commodity of indirect exchange.

- Exchange networks found in the social system of technology are based on end-item products, not knowledge.

- Strong norms against free exchange or open access to knowledge with others outside the organization exist in the social system of technology.

- Restriction, security classification, and proprietary claims to knowledge characterize the social system of technology.

Scientist

- Contribution is new and original knowledge.

- Reward is social approval in the form of professional [collegial] recognition.

- Recognition is established through publication and claim of discovery.

- A well-developed communication system based on unrestricted access is imperative to recognition and claim of discovery.

- Since recognition and priority of discovery are critical, strong norms against any restriction to

free and open communication exist in the social system of science.

- Seeking rewards that are not part of the social system of science in return for scientific contribution is not considered proper within the social system of science.

- Exchange networks commonly referred to as "invisible colleges" exist in the social system of science; in these networks the commodities are knowledge and recognition (Price, 1961; Crane, 1972).

Influence on Information-Seeking Habits and Practices of Engineers

The nature of science and technology and differences between engineers and scientists influence their information-seeking habits, practices, needs, and preferences and have significant implications for planning information services for these two groups (1966). Taylor (1986), who quotes Brinberg (1980), offers the following characteristics for engineers and scientists: "Unlike scientists, the goal of the engineer is to produce or design a product, process, or system; not to publish and make original contributions to the literature. Engineers, unlike scientists, work within time constraints; they are not interested in theory, source data, and guides to the literature nearly so much as they are in reliable answers to specific questions. Engineers prefer informal sources of information, especially conversations with individuals within their organization. Finally, engineers tend to minimize loss rather than maximize gain when seeking information."

Anthony, et al., (1969) suggest that engineers may have psychological traits that predispose them to solve problems alone or with the help of colleagues rather than finding answers in the literature. They further state that "engineers like to solve their own problems. They draw on past experiences, use the trial and error method, and ask colleagues known to be efficient and reliable instead of searching or having someone search the literature for them. They are highly independent and self-reliant without being positively anti-social."

According to Allen (1977), "Engineers read less than scientists, they use literature and libraries less, and seldom use information services which are directly oriented to them. They are more likely to use specific forms of literature such as handbooks, standards, specifications, and technical reports." What an engineer usually wants, according to Cairns and Compton (1970), is "a specific answer, in terms and format, that are intelligible to him— not a collection of documents that he must sift, evaluate, and translate before he can apply them." Young and Harriott (1979) report that "the engineer's search for information seems to be based more on a need for specific problem solving than around a search for general opportunity. When engineers use the library, it is more in a personal-search mode, generally not involving the professional (but "nontechnical") librarian." Young and Harriott conclude by saying that "when engineers need technical information, they usually use the most accessible sources rather than searching for the highest quality sources. These accessible sources are respected colleagues, vendors, a familiar but possibly outdated text, and internal company [technical] reports. He [the engineer] prefers informal information networks to the more formal search of publicly available and cataloged information."

Evidence exists to support the hypothesis that differences between science and technology and scientists and engineers directly influence information-seeking habits, practices, needs, and preferences. The results of a study conducted by the System Development Corporation (1966) determined that "an individual differs systematically from others in his use of STI" for a variety of reasons. Chief among these are five institutional variables— type of researcher, engineer or scientist; type of discipline, basic or applied; stage of project, task, or problem completeness; the kind of organization, fundamentally thought of as academia, government, and industry; and the years of professional work experience."

NASA/DoD Aerospace Knowledge Diffusion Research Project

This four-phase project is providing descriptive and analytical data regarding the flow of STI at the individual, organizational, national, and international levels. It is examining both the channels used to communicate STI and the social system of the aerospace knowledge diffusion process. Phase 1 investigates the information-seeking habits and practices of U.S. aerospace engineers and scientists and places particular emphasis on their use of government funded aerospace STI. Phase 2 examines the industry-government interface and places special emphasis on the role of the information intermediary in the knowledge diffusion process. Phase 3 concerns the academic-government interface and places specific emphasis on the information intermediary-faculty-student interface. Phase 4 explores the information-seeking behavior of non-U.S. aerospace engineers and scientists from Brazil, Western Europe, India, Israel, Japan, and Russia.

The results will help us to understand the flow of STI at the individual, organizational, national, and international levels. The results of our research will contribute to increasing productivity and to improving and maintaining the professional competence of aerospace engineers and scientists. They can be used to identify and correct deficiencies, to improve access and use, to plan new aerospace STI systems, and should provide useful information to R&D managers, information managers, and others concerned with improving access to and utilization of STI. The results of our research are being shared freely with those who participate in the study (Pinelli, et al., 1990).

A User-Oriented Research Agenda for STI: Topics for Consideration

How people seek information is the most fundamental theoretical and overarching issue in library and information science. Its importance stems from the practitioners concern for efficient and economic operation of library and information science services. The dramatic rise in the availability and kinds of computer and information technology has brought about the need to rethink and reexamine this issue. Aloni (1985) makes the point that library and information science research continues to focus on the problems related to the mechanization and automation of library and information services and less on the user. He contends that a "basic grounding in the behavioral sciences and organizational science is a prerequisite because such an understanding is needed to understand the user." The following quotation from Allen and Cooney (1973) serves to support this position:

Although considerable effort has been devoted to evaluating the effectiveness of information acquisition mechanisms, the effort has been, for the most part, restricted to the evaluation of hardware and software systems. Little is known about the human element in the acquisition process... Since research into the dissemination process has shown the overwhelming importance of personal contact, such approaches to acquisition will have a natural kinship with the dissemination system. In fact, they may prove to be more effective than all the hardware, software, and print-oriented devices combined.

The user, then, becomes the central component to the provision of information and the theme of this agenda. Emphasis on the user is based on the premise that an understanding of information-seeking behavior is essential to the design and provision of information policy, products, services, and systems. Regardless of what other parameters are considered in the design and provision, it is necessary to consider the potential use and mode of use by the person(s) and groups for whom the policy, products, services, and systems are intended.

Background

Considerable research and numerous "user" studies have been conducted over the past 35 years. The generally held belief is that (1) the results of this research and these studies have not accumulated to form a significant body of knowledge that can be used by information professionals and (2) the "results that are usable" have been virtually ignored by those concerned with the design and provision of information policy, products, services, and systems.

Despite the expenditure of considerable funds and effort, there is no generally accepted or systematically acquired body of research that can accurately describe or explain information-seeking behavior or predict the use of information other than at the most elementary levels. A variety of environmental and structural changes, including the growth of computer and information technology, combine to significantly weaken the relevance and reliability of this research. Hence there is the need for a user oriented research agenda.

An acquired body of research is vital to the development of theory and the solution of professional problems, to the formation of tools and methods for analyzing organizations, services, environments, and behaviors, for determining the cost and benefits of information products, services, and systems, for establishing and developing theories upon which to base practice, and for contributing paradigms, models, and radically new conceptualizations of library science and information science phenomena.

Research Agenda

The goal is the creation of a generally accepted, systematically developed and implemented, but user focused, research agenda for AGARD (Advisory Group for Aerospace Research and Development) TIP (Technical Information Panel) member countries. (The creation of another "laundry list" of things that should be done, is not included as a part of this research agenda.) The term user includes any person(s) or groups of persons involved in the production, transfer, use, and management of information. Finally, information use seldom exists as an isolated incident. Information use usually takes place within organizational and interpersonal contexts. Therefore, it should not be studied in isolation but rather in an holistic environment.

Once implemented, this research agenda could be completed within 3–5 years. The results would be generalizable to AGARD member nations, would form the basis for the development of theory-based practice, and would form a significant body of knowledge that can be used by AGARD information professionals for policy, practice, product, and systems development.

1. Previous research regarding the information-seeking behavior of "users" is noncumulative, has been variously criticized, and has largely been dismissed on the basis of research and scholarship.

    A. Conduct a "critical" review, analysis, and evaluation of previous research, identify and remove spurious research findings, and establish a starting point or foundation for "what is known and

accepted as fact" vis-a-vis information-seeking behavior.

    B. Identify the criticisms and deficiencies of previously used research designs and methodologies and compile a "lessons learned" to guard against committing the same or similar mistakes.

    C. Consider lessons learned in the context of existing research designs and methodologies and identify those that correct or compensate for previous mistakes.

2. Previous research regarding the information-seeking behavior of "users" has been limited to a particular system, product, or service in a particular organization or environment. Hence, the results are often confusing, conflicting, and are not sufficient to form the basis for the development of theory.

    A. Develop standard definitions, terms, and terminologies.

    B. Develop, test, and validate research tools, instruments, and techniques.

    C. Develop a standard set of variables.

        1. Types of Users
            a. Engineers
            b. Scientists
            c. Intermediaries
            d. Gatekeepers
            e. Managers

        2. Types of Organizations
            a. Academic
            b. Government
            c. Industry

        3. Size of Organization
            a. Small
            b. Medium
            c. Large

        4. Types of Environment
            a. Research
            b. Development
            c. Design
            d. Manufacturing
            e. Production
            f. Test and Evaluation
            g. Marketing and Sales
            h. Service and Maintenance
            i. Management

        5. Types of Data
            a. Textural
            b. Numeric
            c. Factual

        6. Types of Product/Service
            a. Print
            b. Nonprint
            c. Electronic

        7. Types of Discipline
            a. Engineering
            b. Science

    D. Determine which variable(s) best describe and explain the use of information in a variety of environments.

3. What is known about the information-seeking behavior of users appears not to explain information use and nonuse. Hence, there is little knowledge that can be used for testing existing and developing new paradigms.

A. Conduct information-seeking behavior "user" research within a conceptual framework that embraces the production, transfer, use, and management of information. One possible outcome could be the identification of barriers that prohibit or restrict the use of information.

B. Seek to understand the diffusion of knowledge as a precursor to describing and explaining user behavior.

C. Develop and test hypotheses, the results of which can lead to the formation of theory that can be used to predict the use of information.

D. Develop a series of experiments, the results of which will lead to the formation of paradigms, models, and radically new conceptualizations of library and information science phenomena.

4. Conventional wisdom states that a "disconnect" exists between theory and practice/researchers and practitioners in the fields of library science and information science.

A. Develop a mechanism that couples the results of basic and applied research with users in the field.

B. Develop the means by which researchers and practitioners will have greater interaction.

Concluding Remarks

Research in library science and information science cannot be viewed as a luxury. It is vital to the solution of professional problems; the development of tools and methods for analysis of organizations, behavior, and services; to determining the costs and benefits of library and information services; to establishing and developing theories on which to base practice; or providing the field with paradigms or radically new conceptualizations of library and information science phenomena.

A number of library science and information science research agendas have been proposed and/or developed over the 20 years. Despite such attempts, there is a lack of consensus regarding what should be researched. A lack of consensus is, perhaps, to be expected in a maturing area such as library and information science. What is missing, however, is a generally agreed upon list of problems or questions important to library and information science. Consequently, there is no agreement on the significant questions concerning the development of theory and the design of research. Both the questions and the answers may be painful. But both are important to the further development of theory and paradigms.

What is needed is to determine what we know and where we are. Use this knowledge as a starting point to determine the questions that must be asked, the answers to which will form the elements of a basic research program and the development of theory-based practice. Applied research can be used to validate and otherwise test this theory. A mechanism is needed to link (communicate) researchers and practitioners and to translate the results of research into practice.

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INFORMATION ACCESS: A RESEARCH AGENDA

Peter Hernon, Ph.D.
Professor, Simmons College
Boston, Massachusetts
U.S.A.

Overview

Lesser (1990, p. 3) makes an important observation:

"Information, increasingly, is becoming a strategic resource for...society and the...economy. It is the basis on which most new jobs are being created, new wealth generated, and new productive activities started. It is a primary determinant of the competitive position of...industry in the international marketplace. In societal terms, it is of growing significance, not only in the role it plays in our economic affairs, but in the way it influences how we live and the way we function as citizens.

Information is also changing in character. First, there is more of it... Second, it is becoming increasingly commoditized, i.e., bought and sold. Third, it is becoming increasingly internationalized... Fourth, it is becoming more transient as a function both of the increasing speed with which new information gets produced and the rapidity of dissemination. Fifth, the presentation formats for information are proliferating... Sixth, the production formats for information are being altered, mainly through the intervention of computer technologies."

He notes that the "questions surrounding the collection, storage, retrieval, preservation, and use of information" have become increasingly complex and have technical, "economic, political, social, and cultural dimensions" (Ibid.). For libraries, information centers, and other safety nets, these questions impact information access. After all, access is directly related to knowledge and information collection, storage, retrieval, preservation, and use. Safety nets, such as libraries and information centers, selectively collect and preserve data, as represented by statistical and visual datasets.

This paper provides a general overview of information access. The issues identified and discussed ultimately have implications for both developed and developing countries [1]. It is important that developing countries recognize and address these issues in national plans and in practice, for the issues relate to information resources management and use, and to scientific, economic, technological, and societal advancement.

The proposed research agenda represents an initial effort to offer direction in an information and electronic age. The agenda provides nations, international bodies, agencies, and organizations with a flexible framework for producing change and for linking that change to decision making and policy review, formulation, and implementation. As Lesser (1990, p. 6) so aptly states, a "research agenda for information studies must include the consideration of the processes of technological change...and an examination of the economic, social, cultural, and political consequences of that change." Clearly, such factors are important but they are not the only factors to include in a research agenda. Nonetheless, "there is no single [or simple] list of research topics which can be identified as the most important—too much is changing, too quickly, for any...simple prescriptive answer to be offered" (Lesser, 1990, p. 10).

The tentative research agenda proposed in this paper must address Lesser's concerns, recognize the lack of a previous agenda upon which to build, and avoid the mere development of highly specialized, research questions lacking broad generalizability and application. Instead, the agenda identifies fundamental issues, each of which could suggest and support multiple researchable problems (see Hernon, 1991, Chapter 1) appealing to researchers in disciplines such as library and information science, computer science, psychology, sociology, public policy, public administration, and engineering. A research agenda, therefore, should provide "common ground" among disciplines and encourage "collaborative research" (Lesser, 1990, p. 8).

Access and Availability

The information professions frequently use the word access in many different ways. That word may refer, for instance, to approachability (freedom of approach), availability, and opportunity (as to copy as well as other aspects of intellectual property rights). In regard to public records, there is a legal right of access which can be combined with a reasonable opportunity to examine or use specific records. Access in a democracy, as a result, becomes an aspect of the people's right to know, and it is important for policy makers to define and use terms such as access and records in the context of the electronic age.

Access and availability to publications are not always the same as access and availability to information. Access and availability to publications are a prerequisite for access and availability to information. The word "publication" refers to the packaging of information, and that packaging takes various forms (e.g., paper copy serials and monographs, audio-visual resources, maps and charts, and videotapes).

Two important, general questions are: "What is adequate public access?" and "How is adequacy defined, achieved, and measured?" The answer to both questions must address various methods by which individuals and providers/safety nets (see Figure 1) obtain information, and the effectiveness and efficiency of these methods in meeting the information needs of the public and target audiences.

All assumptions underlying public access must be identified and the effectiveness and efficiency of that access measured. "Adequate" public access must be clearly defined and ensure the receipt of understandable, accurate, and perhaps current information; information at an affordable cost; information appearing in convenient and readily usable formats; reasonably priced information; and the acquisition of information with the least expenditure of physical effort. Information should be openly available, where possible, which means "available without prior restrictions" (except those explicitly identified in existing statutory, administrative, or case law, and without procedural complications) (National Commission on Libraries and Information Science, 1982, p. 23). However, availability and accessibility are meaningless if the public does not perceive certain types of information, e.g., government information, as a logical option for the resolution of actual information needs.

Access to government information, for instance, and the concept of adequacy must also be viewed in relation to the following factors:

- Political and organizational: the views, value assumptions, and objectives of a bureaucracy or politician about the government's role in the provision of information. Another factor is the degree to which the management of government information enhances the accomplishment of political objectives;

- Information to be made available: identification of the content or specific data elements that government might provide to the public;

- Bibliographic control;

- Dissemination methods;

- Publication formats; the decision about whether to issue and use paper copy publications, microforms, etc.;

- User awareness: knowledge that the information exists.

- Barriers to information gathering; and

- People's previous experiences in gathering and using information.

Effective public access presupposes that a government encourages both accessibility of, and availability to, information. A democratic form of government must fully recognize its responsibility to communicate, as fully and reliably as possible, with those whom it governs.

Access issues can be viewed from at least three different perspectives: those of users; institutional providers and safety nets, including libraries, information centers, and the private sector; and policy makers and policy frameworks. Depending on the information needed and sought, it is possible to categorize access by "a series of steps or stages. Not all steps are required in every circumstance, nor are they necessarily sequential" (Hill, 1987, p. 17). Although Hill's steps apply to access to foreign scientific and technical information, most of the steps have broader application. In addition, these steps can be viewed from the perspectives of users, institutional providers and safety nets, and policy makers and policy frameworks.

The steps are (Ibid., pp. 17–30):

- "Assuring legal access (e.g., overcoming private property rights and national or commercial security);

- Selecting relevant information to acquire;

- Acquiring that information;

- Translating acquired information (applies in some instances);

- Disseminating information;

- Interpreting information and determining its value and utility; and

- Evaluating information access programs and services—their procedures and performance."

These steps involve more than information resources management. They assume a proactive position and raise significant cost issues.

Buckland (1991, pp. 78–79) identifies types of barriers that hinder advancement through the series of steps and achievement of the ultimate goal—use of information sought and received to achieve some end. Four barriers that he identifies merit brief mention:

- "Price to the user;

- Cost to the provider;

- The necessary expertise to understand the information acquired or user ability to obtain a clear explanation of that information; and

- User acceptance of the information."

The first two barriers suggest a number of issues relating to information as an economic resource, while the other barriers serve as a reminder that there is both physical access and intellectual access. Intellectual property rights might comprise another barrier, one impacting both physical and intellectual access. Access issues, therefore, must take into account current and potential users and their information-gathering behavior, as well as address technological, social, economic, legal, and political matters.

Historical Background

Prior to World War II, attention focused on access to the graphic record as depicted primarily in printed sources, paper copy and microform. There was the belief that the population of printed sources could be placed under bibliographic control [2] and physically acquired by national libraries and the major research libraries. The proliferation of sources during and immediately following the war did not alter this perception.

During this time, the Farmington Plan emerged. Under it, the research libraries in the United States divided the world into spheres of collection responsibility and sought to acquire all publications of a country and region. National libraries also participated in this worldwide venture. Nonetheless, the number of government publications produced within the United States and elsewhere, combined with the existence of elusive and ephemeral publications, underscored the inability of any one approach to provide bibliographic control and access to everything produced worldwide.

As research libraries experienced space shortages and a limited need for certain publications, they further explored cooperation and participated in resource sharing networks. Nonetheless, the decades of the 1950s, 1960s, and 1970s were times of phenomenal collection growth, due to the availability of vast financial resources.

By the 1980s, this pattern of unbridled growth subsided and came to an end. More libraries and information centers began to experience "rising costs and dwindling budgets" (Nicklin, 1992, p. A1) [3];

"the buying power of academic libraries has waned as their budgets experienced little or no growth. Now [1992], intense financial pressures brought on by the recession and the skyrocketing cost of academic materials are eroding even more of that buying power."

As libraries and information centers have reduced the number of sources purchased, the inevitable result is the emergence of significant "holes" in library collections of "scholarly works" and technical reports (Ibid., pp. A1, A28).

At the same time, the information age has lead to the availability of vast numbers of electronic information products and services which complemented, and in some instances have replaced, printed sources (see Hernon and McClure, 1992). Now libraries, information centers, and the public encounter CD-ROM products, electronic bulletin boards, floppy disks, magnetic tapes, and so forth. Some of this information is perishable, or has short-term impact, while other information products have a longer term impact and merit archiving.

This explosion of electronic information underscores that we must not approach information access simply from the collection of a particular institution, such as a library or information center. Information access transcends physical ownership and encompasses an ability to negotiate the information environment for the identification and retrieval of high quality, relevant, useful, and understandable information—information that will make a difference (see Figure 1).

One difference between the days of the Farmington Plan, or the pre-information explosion, and the 1990s is that libraries, information centers, and other institutional safety nets are now more interested in access to relevant information—information directly related to accomplishment of their missions and goals—than in acquiring vast quantities of superfluous or unwanted information. The focus, therefore, is on quality, not quantity, of information, and on the use of that information. (An extended discussion of use would have to focus on the frequency and types of use.)

Another difference between then and now is that information access used to be a concept that stood alone. For years, libraries and information centers regarded access as perhaps the single-most important issue and expected others to share this opinion. Now, information access has become linked to the information life-cycle, but it is not necessarily the most important aspect of the life-cycle. As this paper discusses, issues related to the production, creation, protection, etc., of information often shape access issues. The life-cycle determines the availability of information products and services, at what cost, and to whom.

Scientific and Technical Information

Since 1945, scientific and technical information (STI) policy within the U.S. government has been decentralized and piecemeal and, at times, contradictory, confusing, simplistic, and based on faulty premises. In other countries, STI policy might be more centralized but perhaps no more efficient or effective. As has been mentioned for years, the scientific community has tended to emphasize production over access, whereas the library and some other communities has focused on access over production. As McClure (1988, p. 41) observes,

"Paradoxically, while...[the U.S.] government continues to spend large amounts of money for mission-oriented research, by comparison, it spends virtually nothing on research for how to best manage, increase access to, and ensure high impact and use of its technical report literature. Simply producing a technical report will not, in and of itself, ensure its access and use by the R&D community. Clearly, additional research support for investigations related to how best to enhance the impact of...technical report literature is needed."

As the paper demonstrates, although production remains important, increased attention now focuses on dissemination and use. Two factors might account for this shift: economic competitiveness and the increased availability and importance of electronic information. There is greater concern about use and impact, or getting the right knowledge, information, and data to those able to use it to produce a scientific or economic advancement having practical and immediate implications.

Current Initiatives

Information Life-Cycle

The information life-cycle, a component of information resources management (IRM), contains six stages: (1) the creation or collection of information; (2) information production; (3) protection and security management (where necessary); (4) transmission (availability, distribution, and dissemination); (5) access, retrieval, and use; and (6) retention and, in some instances, retirement. Each of the six stages presumably flows from (and relates to) the previous ones (see Figure 2).

The life-cycle concept is flawed in two fundamental areas. First, STI, especially that for aerodynamics and aeronautics, may never reach the final stage, retirement. For example, the National Advisory Committee for Aeronautics (NACA) published more than 16,000 technical reports between its founding in 1915 and its demise in 1958. Aeronautical engineers and scientists worldwide still use many of these reports (Anderson, 1974).

Second, the availability of the TIGER-files on CD-ROM [4] underscores that information users can make special queries of a system, produce their own datasets, and thereby create or produce knowledge or information. In other words, they can move from access or retrieval to knowledge or information creation and/or production, thereby complicating the image of the life-cycle as a series of discrete steps moving uninterrupted from the first to the last. (Figure 3 illustrates that information access can forge a link to earlier steps in the life-cycle.) The danger for some governments, businesses, and individuals is that the interplay among the six steps in the life-cycle may result in the mosaic theory, or the ability to create information from the open literature that should be protected because it might cause irreparable harm to a government or those governed.

Dissemination

The first Interagency Conference on Public Access, which the U.S. Environmental Protection Agency sponsored in 1991, grew out of concerns for legislative and mission requirements specifying increased public access to information created and held by federal agencies, and the attention that Congress, the agencies, professional associations, academe, and the press have given to access issues.

Examination of the summary report of the conference ("Interagency Conference on Public Access," 1992, p. 194) indicates, for example, that:

- "Public access is a secondary issue to a primary mission;

- Dissemination systems must involve products amenable to electronic dissemination;

- There is a difference in perishable data and longer term, archival information, such as research data; these differences must be accounted for in the design of a system;

- Dissemination must be factored into the design of a system; decision must be made regarding the best mechanism to get the information out to the public;

- Marketing is easier in the private sector but it is essential to the success of most dissemination systems;

- Agencies must determine what information is useful to their constituencies and what is required to meet the needs of particular users; and

- Pricing should reflect the cost of dissemination and not attempt to tap into the revenue stream."

Conference participants divided into working sessions on policy and implementation issues related to public

access. The former group identified issues such as (Ibid., pp. 195-196):

Costs

- "There needs to be more consistency in pricing policies. There is a problem in determining 'marginal direct or indirect costs,' these may differ for different information;

- Vendor re-sale could be an issue if users got together and bought once and then shared; and

- The U.S. Freedom of Information Act is a good model as it only involves a direct cost charge."

Types of information

- "Mission critical information, primarily for internal use, may have by-products which need to be made publicly available at marginal, non-capital costs;

- There is a clear obligation for agencies to disseminate information effectively and efficiently to the general public, especially that which is collected to carry out the mission. There is also a clear obligation to go further for certain classes of information. Given this responsibility, there need to be guidelines for easily defining "trivial" data that need not be disseminated. What type of information do the agencies have a responsibility to disseminate? Classes of information include:

  - That information which must be disseminated, i.e., patent applications which may or may not be provided at a fee, based on the mission goal;

  - By-product information already capitalized and which can be provided with no extra effort; and

  - Information for which there is no obligation to provide, but which it would be nice to provide."

Responsibilities and mechanisms for dissemination

- "Agencies are responsible for dissemination decisions based on mission and constituencies. Local judgments should govern decisions to disseminate and on what, and how, information is disseminated. Agencies should exercise controls over re-sales;

- Use of vendors, resellers, and intermediaries vs. in-house systems; and

- Services to citizens differ from service to commercial users; fees and controls differ."

The implementation group examined issues related to inventory, steps in the implementation process, problems in implementation, and what can be done to move agencies forward. Inventory issues, for example, involve an identification of government-wide information locator systems, establishment of newsletters and bulletin boards to facilitate sharing, and the development of interagency groups to share experiences.

Some steps in the implementation process include (Ibid., p. 196):

- "Decisions on who pays and the cost;

- Data refreshment—archival versus 'out of date' usage decisions;

- Constituency/requirements issues and priorities... specialized publics, intermediaries, and technical levels of usage;

- System design;

- Inventory of what should be disseminated; information that is available and needs to be shared with the public;

- Define the public—general public, technical communities, or specialized groups. Leverage resources to reach other audiences, through levels of dissemination. Use advisory groups to assist in customer analysis and carry out market research; and

- Identify demands."

Problems in implementation include:

- "Funding development;

- Lack of commitment to public access at high levels;

- How to address equity in implementation; cannot assume that public libraries, or the general public, are ready for this;

- Ability of the government to market its information; and

- Security implications—availability, integrity and data accuracy, and confidentiality."

The final category of issues relates to "what can be done to move agencies forward?" Examples of these issues include (Ibid., p. 197):

- "Do a better job of identifying who is the public in early design stages; aiming at institutional or individual users; accept the fact that serving segments of the public is all right;

- Leverage resources through use of intermediaries;

- Obtain high level commitment for public access; and

- Encourage a national investment in infrastructure...to ensure equity of access."

With the increased availability of government information in electronic form, government agencies need a policy framework for defining their own policy and procedures, and for offering information "in a useful and cost-effective manner." Both the policies and guidelines that agencies develop independently "should be consistent in direction reflecting a single broad federal policy on public access, with variations based on the special requirements of the agency" ("Public Access to Government Electronic Information," 1993).

Among the many provisions of the draft policy framework, three merit mention. First, "agencies must define their public." Second, "agencies should validate demand before initiating a dissemination program." And, third, "agencies should include state and local governments in the planning of dissemination systems, both as recipients and providers of data" (Ibid.).

A policy framework for dissemination needs to consider ethical issues relating to data access, accuracy, and security, as well as the possibilities for data recombination—including the mosaic theory, fraud, and abuse. For example, computer matching "is a technically and ethically complicated subject with far-reaching administrative, law enforcement, and privacy implications" (Office of the Information and Privacy Commission/Ontario, 1992, p. 48). Furthermore, "the acceptability of computer matching depends, in part, on establishing a balance between the legitimate information needs of government and individuals' rights to privacy" (Ibid.).

Government Information Locator Systems

Successful management of government information resources requires that agencies and users know what information is available and where it is located. Due in

part to the piecemeal, decentralized approach to government information policy within the United States, there has been no comprehensive identification of information inventory or locator systems within the U.S. government, and little oversight of agency compliance with existing congressional requirements related to maintaining such systems. As well, it remains to be seen if (and how) "a series of distributed systems operated and maintained by individual agencies" can become "a gateway service. In this way, agencies and the public can use the electronic 'Yellow Pages' in one-stop shopping" (Bass and Plocher, 1991, p. 29).

A government information and locator system should identify which information agencies collect, maintain, and disseminate, "as well as regulations, and agency information holdings and systems." The pointer system should also "identify and describe information, suggest connections to other data, give agency contacts, and describe how (if possible) one can assess the underlying information" (Ibid.).

Further, Bass and Plocher (Ibid.) envision a system that "should actually give access to government databases, provide copies of paperwork and regulatory requirements, conduct consumer transactions (e.g., purchasing materials listed on the system), and offer IRM tools to agencies."

The system, they point out, "is the bridge to enhanced public access and improved management of information resources and needs to be built in a manner that permits its own expansion and restructuring" (Ibid.). Furthermore, as technology evolves, so should the system and its ability to interact with systems produced by other levels of government.

Safety Nets

Government information policies and practices provide for safety nets to protect and foster the public's right-to-know. Through access to safety nets, people can hold their government accountable and obtain needed information, while government itself can maintain a "checks and balances" system and ensure proper power balances among branches of government and equity in policies and practices.

Countries may have three basic approaches for the provision of government publications and information to the public. The first approach involves the reporting on activities and policies through newspapers and the mass and electronic media. The second approach includes printing extra copies of government publications (or copying information products) for public distribution through legally sanctioned depository programs, sales programs, clearinghouses, information centers, or distribution centers. The final approach enables the public to request internal information contained in agency records by invoking a freedom of information act.

There is no (and should not be any) single, all encompassing, government information safety net. In fact, there is duplication between/among different safety nets. Duplication may be desirable, however. It ensures that the public and the branches of government have different channels for gaining access to government information.

A problem in an information and electronic age is that safety nets change and the public often has little awareness of the panorama of institutional and legally sanctioned safety nets, and how these various parts of the access puzzle fit together. Policy makers, researchers, and others often study a particular safety net, without examining its relationship to other safety nets. Clearly, improved public access depends on an examination of the larger picture and adapting that picture to changing policies, practices, and times. The public and specific target audiences must

be aware that options and alternatives for information access exist, and they must know the types of information available from each safety net and in what medium.

Publics

As the summary report of the "Interagency Conference on Public Access" (1992) demonstrates, government agencies are becoming more concerned about dissemination and addressing the public's (and target audiences) information needs. Both the public sector and safety nets find it important to define their public or publics, and the role that they can play in resolving the public's information needs. Undoubtedly, the necessity of maintaining public support and confidence during a recession and at a time when the international scene has undergone profound changes explains part of the concern on part of the different levels of government within the United States for the identification of their publics. Another reason for their identification might be to reverse dwindling budgets by finding and exploiting areas in which agencies might generate revenue (Allen, 1992).

At any rate, the focus on the identification of publics serves as a reminder that access issues and information systems must address the information needs and information-gathering behavior of those people they intend to service. Without such input, costly systems emerge and the consequences are disastrous: under-utilization of the system, inefficiency, irrelevancy, and wasted expenditures.

Electronic Information

Published knowledge and information appear in the form of monographs, journal articles, conference proceedings, dissertations, technical report literature, and so forth. These forms might be conveyed as paper (hard or soft cover) or microform publications. Knowledge, information, and data might be available as a CD-ROM product or as part of a bulletin board or an online database. Primary source material might also be presented on floppy disk or magnetic tape.

Electronic information and data might appear through either reference or source databases. The former include bibliographic databases, which contain citations to a literature, and referral databases, which offer references to unpublished information and offer referral to individuals, organizations, and information resources. Source databases, on the other hand, include numeric databases, which provide statistical data; textual-numeric databases, which combine text with fields of numeric data; visual databases, which display digital mapping and visual images; full-text databases, which offer the complete text of an item; and specialized software, which contains complete programs that make possible the downloading of entire files or parts of files possible and which operate on microcomputers, mini-computers, and mainframe computers (see Directory of Online Databases, 1990, pp. vii–viii).

The array of forms and formats both complicate and ease information access. Instead of reducing the amount of information and data available, the opposite has occurred. The amount has increased while the proper safeguards for preserving this information and data, and for later generations to use the information and data, may be absent or in an infancy stage of development. Too frequently, insufficient attention has been given to the final stage of the information life-cycle: archiving, preservation, and retirement of information (see National Academy of Public Administration, 1991).

Networks seeking to be responsive to the information needs of their clientele attempt to improve the effectiveness and efficiency of their access to information and data.

These networks establish new delivery systems (fax, on-line, and mail) and improve existing ones as they offer better access to information and data that are needed but not locally held. The challenge for libraries and information centers (as well as other safety nets) will be "to support the old information sources and invest in new ones as well as in the infrastructure to support them" at a time when these safety nets may not be able to afford or justify the expenditures (Lynch, 1991, p. 20). Some or much of these new information sources might comprise "a new class of 'gray' literature" (Ibid., p. 9).

At any rate, a fundamental question becomes: "How much (and which) information and data do libraries and other safety nets need to provide?" Information and data exist in profusion and...[are] increasing at an exponential rate" (Brinberg, 1989, p. 63).

According to Brinberg (Ibid.),

"the question is not whether we have enough information [and data]. Rather the questions are: Where...[are] the information [and data] and how do we get at...[them]? This dilemma is compounded by the proliferation of personal workstations, distributed processing and storage of data, and the cacophony of software languages, network protocols, and hardware standards."

Lynch (1991, p. 20) speculates that "library collections in electronic form, along with appropriate access systems, will not suddenly appear on...[an electronic] network, replacing current traditional libraries that house books and journals." He envisions more of an incremental development or transformation taking a couple of decades to complete. Perhaps his vision might not emerge. A basic premise of this paper is that traditional libraries and traditional books and periodicals will never die out. They will always play a role; that role, however, might change.

National Research and Education Network

The High-Performance Computing Act of 1991 (P.L. 102-194), which President George Bush signed on December 9, 1991, calls for

"a high-capacity and high speed national research and education computer network...[to] provide researchers and educators with access to computer and information resources and [to] act as a test bed for further research and development of high-capacity and high-speed computer networks."

Some researchers have referred to the development of the National Research and Education Network (NREN) as perhaps "the single most important factor affecting the ability of the United States to manage information resources effectively in the 1990s" (McClure, Bishop, Doty, and Rosenbaum, 1991, p. i).

Lynch (1991, p. 7) suggests that

"the NREN will have a major impact on the entire system of scholarly information and communication, including access to databases, the transformation of libraries, and new connections between the processes of scholarship, education, and industrial research."

He indicates that "access to networked information and communication will be the two major applications of the NREN" (Ibid.). Further,

"widespread effective access to information will be essential if NREN is to achieve its goals of improving education and research and technological competitiveness. Accessible information will include abstracting and indexing...databases, particularly in science, engineering, and technology, and numerical and factual databases produced by industry, government, and the university and research communities. These databases may ultimately prove to be of greater value than access to traditional book-oriented online library catalogs" (Ibid.).

"Improved access to the essential 'gray' literature of technical reports and government documents will yield large dividends" (Ibid.), so too might improved access to source databases.

As NREN starts to take shape and realize the aspirations of its advocates, new issues will emerge. A public network, such as NREN, is crucial to the continued productivity and competitiveness of the United States. However, the contents of the network as well as access to these contents may not be confined to users of the one country [5]. In case of such an eventuality, increased productivity and competitiveness assume worldwide implications and do not convey advantage to any single country.

As Prentice and Hill (1992) point out, "we are embarking on a cost-justification, cost-benefit crusade against other competing and compelling demands." Furthermore, technical issues associated with NREN's development may be easier to resolve than the social and behavioral issues (see McClure, Bishop, Doty, and Rosenbaum, 1991). Such observations are most important and serve as a reminder that there will be a series of decisions and trade-offs, some of which pertain to intellectual property rights and legal statutes. It is important to ensure that during NREN's developmental and implementation stages, important and potentially irreplaceable services are not lost and users are not ill-served.

Future Trends

Although it is impossible to predict the future with any certainty, some definite trends are emerging. First, information-handling technologies will increase physical and intellectual access to more information sources. A question becomes "To what extent will institutional producers, providers, and safety nets supply perishable and other information in electronic forms, and how much of this information will networks provide?" Furthermore, what will be the implications for access to paper-based information products?

A second trend is continuation of efforts to improve bibliographic control and physical access to all publications and information products produced. As Figure 1 illustrates, such a goal is difficult, if not unrealistic, to achieve. The more critical question is "How do we identify and provide access to that knowledge, information, and data that are needed and that will make a difference?" Three related questions are:

- "How do we reconsider the concept of the information life-cycle for STI so that retirement focuses more on archiving than on destruction?"

- "Who will decide what knowledge, information, and data will make that difference?"

- "Based on what criteria and policies will they make that decision?"

Of course, sheer quantities of publications and information make archiving of everything—STI and other—either an elusive dream or a frightful nightmare.

Figure 4 serves as a reminder that both general and specialized safety nets exist. Too much attention has focused (and undoubtedly will continue to do so) on individual ones, or parts of the access puzzle, not the entire picture. In other words, we tend to forget a fundamental principle of systems analysis: the whole is more than the sum of its parts.

As the concept of access becomes more sophisticated and intricate, information professionals require education and training to keep abreast of change. They must ensure that:

- Their clientele, present and potential, meet their information needs as promptly and as cost-effectively as the safety net can afford; and

- The safety net to which they are associated has the necessary technology to meet the changing needs of the clientele and to manage information resources properly.

And, finally, the prevailing pattern has been to base a number of decisions about the effectiveness and efficiency of programs, services, and operations on intuition or testimonials of a few. Now is the time to stop engaging in "evaluation by testimonial" and to gather the "hard data." After all, testimonials may well produce erroneous, misleading, or incomplete findings. The NREN that finally emerges must address the information needs and information-gathering behavior of its users and not merely systems designers and engineers.

A Research Agenda

Overview

The following agenda lacks the specificity of some other research agendas and thereby attempts to avoid their weaknesses (see McClure and Hernon, 1991). The purpose of the agenda is to offer a preliminary basis for national and international discussion, and to stimulate and encourage the conduct of research on specific topical areas. The agenda provides a range of choices and opportunities to identify different research problems and shape strategies for attacking those problems.

At least five factors are central to the development of an agenda, and national and international policy, covering information access (see Brinberg, 1989, p. 63). First, the public, including target audiences, requires greater knowledge about the availability and utility of information sources. Second, there should be more rapid access to (and assimilation of) information. Third, there is need for "better tools for the retrieval, management, integration, and communication of information" (Ibid.). Fourth, without the development and implementation of standards for hardware, software, and telecommunications, "the vision of the 'wired' society" cannot become a reality (Ibid.). And, fifth, there must be "open borders for the free flow of information" (Ibid.).

A Proposed, Tentative Agenda

The following 30 topical areas were developed from an examination of "Information Policy Concerns in the Year 2000" (1989), "Establishing a Research Agenda" (Blados, 1991), "Issues in State Information Policy" (Currens and Sims, 1989), "A Library and Information Science Research Agenda for the 1980s" (Cuadra et al., 1982), Rethinking the Library in the Information Age (1988–1989), and personal views of this author.

An agenda for information access might cover the following points:

1. The impact of the medium (type and format) in which knowledge, information, and data are presented on information access;

2. The extent to which quantity of knowledge, information, and data on a topic inhibit access to that knowledge, information, and data that will make a difference. Whether or not the information "glut" promotes or diminishes user access;

3. "The properties of information, its impact on society, its dissemination and access" (Rethinking the Library in the Information Age, 1989, p. 4);

4. "Access to information services in the workplace" (Ibid.) and the impact of spiraling costs and declining budgets on the ability of libraries and information centers to collect and provide access to information services on both a short-term and long-range basis. And, the impact of collection growth/stagnation on the information needs and information-gathering behavior of library/information center clientele;

5. Service quality, or "meeting the public's expectations," and "the rising demands for public services in the environment of continual revenue shortages" (Thompson, 1991, pp. 1, 3, 10, and 13);

6. Access and cost concerns;

7. Access and privacy/security concerns;

8. The impact of information overload on information access and use. Effective and efficient strategies for disseminating higher quality resources and for offsetting information overload, where a problem exists;

9. The application (or lack thereof) of the information life-cycle on STI, and refinement of the model as necessary ("Consider the broader...information policy sys·⋯ ⋯ it relates to the collection, organization, and dissemination of technical reports [and other information resources]" (McClure, 1988, p. 38));

10. What is adequate physical and intellectual access to government and non-government information;

11. The extent to which technology causes "glut conditions without improving real access" and whether "the information 'glut' available through data base systems (the format or presentation of information) promotes or diminishes users' access" (Rethinking the Library in the Information Age, 1988, vol. 1, p. 17);

12. The extent to which training programs for the staff of libraries, information centers, and agencies result in better provision of access to information;

13. The extent to which performance measures for libraries and information centers can improve the quality and quantity of services provided to STI users (see Hernon and McClure, 1990, Chapters 8 and 9);

14. Development, testing, and refinement of a user-access model that includes variables such as awareness, "organizational culture," "attitude toward information and communication technologies," one's own skill and level of training in retrieving information, relevance, quality, and financial resources (see McClure, Bishop, Doty, and Rosenbaum, 1991);

15. Equality of access to government/non-government information, seeing that those needing information receive it and know how to use it (this topical area includes the free vs. fee debate);

16. Availability of technology in the future that can read electronic information and data of today and yesterday (The extent to which "information gaps" exist and information is unavailable to those entitled to its use);

17. Extent to which new information technologies are cost-effective and ensure access for people with varying backgrounds and levels of computer literacy;

18. The impact of networks and information-handling technologies on information access, and the extent to which telecommunications infrastructures meet the need for information access and transfer;

19. "Access to electronic data and potential trends toward loss of information access by the economically underprivileged" (Rethinking the Library in the Information Age, 1989, p. 4);

20. Ability of libraries and information centers to provide their clientele with lesser-needed materials from remote storage and through inter-institutional lending;

21. The extent to which libraries and information centers meet their mandated mission, goals, and objectives;

22. The relationship between the public and private sectors in information provision and access, "the balance between governmental and commercial means for provision of information from...government records" (Rethinking the Library in the Information Age, 1989, p. 4);

23. High-speed computer networks and how they can facilitate users' access to networked information resources;

24. Locator systems as "one-step information processing systems." Examine the various safety nets and information locator systems and determine how these pieces of the information access puzzle can be pieced together, thereby enhancing public access;

25. Levels of bibliographic control and the extent to which each level provides specific user groups with acceptable access to specific types of information;

26. New methods of storage and dissemination, new systems for information and data access, and new methods of information resources management. For example, examine decision support and expert systems;

27. "The implications of regionalism for information cohesiveness...[and] the relationship of regional communication networks to international networks" (Doran, Dosa, and Rosenbaum, 1991, p. 128);

28. Perceived versus actual barriers to information access (within libraries and information centers, for instance), the extent to which physical layout of the library or center impacts on access;

29. Government activities relating to quality control and information dissemination [6]; and

30. Standards for information and data interchangeability and use, and bringing the knowledge bases residing in many scattered reservoirs directly to users [7].

To make the agenda more useful and usable, we can group the 30 items into nine general categories, which are not mutually exclusive (see Appendix A). Information resources management, followed by libraries/information centers/safety nets, are the two largest categories. Dissemination might be considered as part of life-cycle management and, therefore, as part of information resources management.

Given the breadth of each topical area, it is important to identify priority research questions and subsequently to convert them into problem statements that guide the conduct and reporting of a study. The 30 agenda items

serve as a starting point for group and national discussion. The list can be altered, reduced or expanded, and made more specific, and funding priorities established.

Ultimately, the research can assume various forms, ranging from experimental to descriptive, and employ a variety of different methodologies. In some instances, the research might center on the development or refinement of a model or prototype. The research might also evaluate existing programs, services, and operations, and result in change, or the research might have clear policy implications at the international, national, regional, and/or local level. Evaluation research might focus on the process of decision making and address the needs and preferences of decision makers. Nonetheless, the research should include indicators or reliability and validity (see Hernon and McClure, 1990, pp. 72-77, 95-102).

Agenda as Modified by Working Group

The Research Agenda contains three themes: (1) Information Management, (2) Provision of Information, and (3) Access to Information. Provision of Information contains two sub-themes (Dissemination and Bibliographic Control), while Access to Information also has two sub-themes (Barriers and Equity, and Networking).

Each theme or sub-theme has four possible aspects: (1) Human Resources, (2) Quality Assurance, (3) Cost, and (4) Technology. It was the consensus of the afternoon working group that, in fact, a theme or sub-theme need not contain all four aspects. The Research Agenda for Information Access therefore will contain the following themes, sub-themes, and aspects:

I. Information Management

   a) Human Resources

   b) Quality Assurance

   c) Cost

   d) Technology

II. Provision of Information

   a) Dissemination

     • Quality Assurance

     • Cost

   b) Bibliographic Control

     • Quality Assurance

III. Access to Information

   a) Barriers and Equity

     • Human Resources

     • Cost

     • Technology

   b) Networking

     • Human Resources

     • Technology

The working group reviewed Appendix A and selected specific topical areas for inclusion under themes, sub-themes, and aspects. Group members did revise the language of some of the topical areas and did add to the list of topical areas. Following is a list of the themes, sub-themes, aspects, and topical areas (see Appendix B for an explanation of the procedures for developing the Research Agenda). These themes, sub-themes, and aspects form the Research Agenda.

I. Information Management

   a) Human Resources

1. The extent to which training programs for the staff of libraries, information centers, and agencies result in better provision of access to information.

2. The extent to which performance measures for libraries and information centers can improve the quality and quantity of services provided to STI users.

3. Development, testing, and refinement of a user-access model that includes variables such as awareness, "organizational culture," "attitude toward information and communication technologies," one's own skill and level of training in retrieving information, relevance, quality, and financial resources.

4. Ability of libraries and information centers to provide their clientele with lesser-needed materials from remote storage and through inter-institutional lending.

5. Need for information specialists to act as information analysts.

b) Quality Assurance

6. Service quality, or meeting clients' expectations, and the rising demands for information services in the environment of continual revenue shortages.

7. The application (or lack thereof) of the information life-cycle on STI, and refinement of the model as necessary.

8. The extent to which performance measures for libraries and information centers can improve the quality and quantity of services provided to STI users.

9. The extent to which libraries and information centers meet their mandated mission, goals, and objectives.

c) Cost

10. Service quality, or meeting clients' expectations, and the rising demands for information services in the environment of continual revenue shortages.

11. Ability of libraries and information centers to provide their clientele with lesser-needed materials from remote storage and through inter-institutional lending.

12. The extent to which libraries and information centers meet their mandated mission, goals, and objectives.

13. Perceived versus actual barriers to information access (within libraries and information centers, for instance), and the extent to which physical layout of the library or information center impacts on access.

d) Technology

14. New methods of storage and dissemination, new systems for information and data access, and new methods of information resources management. For example, examine decision support systems, expert systems, graphical systems, and multimedia.

15. Standards for information and data interchangeability and use, and bringing the knowledge bases residing in many scattered reservoirs directly to users. Examination of knowledge base versus database, and the development and application of information technology standards.

II. Provision of Information

a) Dissemination

Quality Assurance

16. The impact of information overload on information access and use. Effective and efficient strategies for disseminating higher quality resources and for offsetting information overload, where a problem exists.

17. Government activities relating to quality control and information dissemination.

Cost

18. New methods of storage and dissemination, new systems for information and data access, and new methods of information resources management. For example, examine decision support systems, expert systems, graphical systems, and multimedia.

b) Bibliographic Control

Quality Assurance

19. Levels of bibliographic control and the extent to which each level provides specific user groups with acceptable access to specific types of information.

20. Standards for information and data interchangeability and use, and bringing the knowledge bases residing in many scattered reservoirs directly to users.

III. Access to Information

a) Barriers and Equity

Human Resources

21. Need for information specialists to act as information analysts.

22. The extent to which performance measures for libraries and information centers can improve the quality and quantity of services provided to STI users.

23. The extent to which training programs for the staff of libraries, information centers, and agencies result in better provision of access to information

Cost

24. The impact of the medium (type and format) in which knowledge, information, and data are presented on information access.

25. "Access to information services in the workplace" and the impact of spiraling costs and declining budgets on the ability of libraries and information centers to collect and provide access to information services on both a short-term and long-range basis. And, the impact of collection growth/stagnation on the information needs and information-gathering behavior of library/information center clientele.

26. Development, testing, and refinement of a user-access model that includes variables such as awareness, "organizational culture," "attitude toward information and communication technologies," one's own skill and level of training in retrieving information, relevance, quality, and financial resources.

27. Equality of access to government/non-government information, seeking that those needing information receive it and know how to use it (this topical area the free vs. fee debate).

28. Extent to which new information technologies are cost-effective and ensure access for people with varying backgrounds and levels of computer literacy.

29. "Access to electronic data and potential trends toward loss of information access by the economical underprivileged."

Technology

30. Availability of technology in the future that can read electronic information and data of today and yesterday. (The extent to which "information gaps" exist

and information is unavailable to those entitled to its use).

31. Software engineering and the integration of information.

32. Examination of gateways.

33. The impact of networks and information-handling technologies on information access, and the extent to which telecommunications infrastructures meet the need for information access and transfer.

34. Man-machine interface and voice recognition, language processing, and user friendly interfaces.

b) Networking

Human Resources

35. Ability of libraries and information centers to provide their clientele with lesser-needed materials from remote storage and through inter-institutional lending.

Technology

36. The impact of networks and information-handling technologies on information access, and the extent to which telecommunications infrastructures meet the needs for information access and transfer.

37. High-speed computer networks and how they can facilitate users' access to networked information resources and satellite communications.

Notes

1. "The need for and use of information in the development process can not be denied. However, most developing countries have not planned for, nor established policies for acquiring, implementing, and effectively using information in their development plans. For information to take on an important role in the development process, it is clear that governments must recognize the need for information and demonstrate a commitment through the allocation of resources. The key question is, what triggers the awareness of the role information plays in development and when does that awareness reach the level of allocation of resources" (Leonard and Mara, 1991, p. 158)?

2. Bibliographic control has been defined in various ways. Basically, it encompasses those "activities directed to ensure the recording of descriptive, subject, and analytical information concerning a body of documentation and the organization of that information...with a view to efficient use" (Marulli, 1979, p. 13). The definition should also provide for the identification of information, the organization and description of information content; and physical access.

3. "According to the American Library Association, the average price of U.S. periodicals increased almost 400 percent from 1977 to 1990... the average price of a hardcover book has more than doubled in the same period, to $40 from $19" (Nicklin, 1992, p. A28).

4. The TIGER-files comprise a computerized geographic information system (GIS) in which users have access to detailed mapping of the United States and basic census data. For a particular census tract or block. they can create special profiles useful for a variety of purposes.

At the same time, satellite and other data "are certain to become a primary GIS data source across the local to global continuum of GIS applications" (Lillesand, 1990, p. 307).

5. "Information exchange is a two-way street in the global economy. No country can forever have a lock on all the information sources" (Brinberg, 1989, p. 62). It is possible to retard, but not stop, the transborder flow of data. Improved economic and other competition depends on access to information and data, and a partnership among government, the private sector, and academe. This partnership is one of cooperation and tension—competition.

6. "Inaccurate or low quality information is not valuable or even desirable to most users. Thus, ensuring access to information involves taking steps to create, gather, disseminate, and store not just data, but accurate and reliable information. Information is sometimes of questionable quality for several reasons..." (Currens and Sims, 1989, p. 11). These reasons merit analysis.

7. "...Since national self-sufficiency (in information) has not been a viable concept for many, many centuries—nations have profited greatly from each other's intellectual and cultural achievements—the information community has a particular interest in cross-fertilization and in easy access to each other's achievements (and failures). Europe has thrived on [a] diversity of approach; it is probable that this rich diversity will continue for the next century" (Collier, 1991, p. 96).

Appendix A

Information Resources Management

5. Service quality, or "meeting the public's expectations," and "the rising demands for public services in the environment of continual revenue shortages:"

- How many questions do staff answer correctly?

- How important is accuracy of the answer (in comparison to other variables)?

- Do staff members offer referral? How important is this?

- Does use of a service result in client satisfaction and willingness to use that service again?

- What is the service quality of information contained in paper copy versus that found in electronic form?

- What is the impact of privatization of information services on service quality?

6. Access and cost concerns:

- What is the cost-effectiveness and cost-benefit of information dissemination and delivery programs?

- What elements should be considered in developing and applying a cost-effectiveness or cost-benefit model?

- Who should pay? How is the decision determined and applied in practice?

7. Access and privacy/security concerns:

- What information/records merit withholding given the changing international scene?

- Who should have access to what data/information, when, and under what conditions?

- What uses will be made of the data/information, and how can certain data/information be better protected? Are there adequate safeguards to prevent violations of personal privacy?

- How can a balance between the legitimate information needs of government and individuals' rights to privacy be achieved?

- Has the organization established an effective information access, security, and risk management program to protect information?

9. The application (or lack thereof of the information life-cycle on STI, and refinement of the model as necessary:

   - Is one stage (information access) more important than the other stages of the life-cycle?

   - Is there a life-cycle for general information and another one for STI? How well does the life-cycle apply to STI? How can the answers to these questions be incorporated into IRM planning and practices?

   - What are the fundamental principles behind the life-cycle? What are the strengths and weaknesses of these principles?

   - Does the life-cycle apply to the retirement of electronic databases, which ones?

24. Locator systems as "one-step information processing systems." Examine the various safety nets and information locator systems and determine how these pieces of the information access puzzle can be pieced together, thereby enhancing public access:

   - What locator systems exist?

   - Can some systems be reconfigured and placed within a larger network? Which ones can be reconfigured and placed in which networks?

   - Will a system lead users to more information sources than what is stored on it?

   - What safety nets exist? What are their mission and goals? How do the various safety nets "fit together" and how does knowledge about the access picture improve public access? What role do safety nets play in providing access to locator systems?

26. New methods of storage and dissemination, new systems for information and data access, and new methods of information resources management. For example, examine decision support and expert systems:

   - How cost-effective or cost-beneficial are these methods and systems?

   - How can decision support and expert systems improve IRM, be used to compile performance measures, and improve public access?

   - What electronic information and data merit preservation, and how? How can the existence of this information and data be monitored so that the necessary retention decisions can be made?

29. Government activities relating to quality control and information dissemination:

   - How is quality determined and introduced as a standard?

   - How extensively do libraries and other safety nets purchase, acquire, and need access to quality information?

- How cost-effective and cost-beneficial are clearinghouses, information analysis centers, etc.?

30. Standards for information and data interchangeability and use, and bringing the knowledge bases residing in many scattered reservoirs directly to users:

   - What are the key information and information technology areas that require standards? For these areas, is there a sufficient base of knowledge to form a standard?

   - How can government and the private sector best coordinate the development of information technology standards?

   - How will the implementation of standards lead to improved information access and services?

Libraries/Information Centers/Safety Nets

1. The impact of the medium (type and format) in which knowledge, information, and data are presented on information access:

   - What medium do clientele prefer? How can/should safety nets address these preferences?

   - Which types and formats receive the most use? How should safety nets factor the answer to this question into their selection, marketing, and retention decisions?

4. "Access to information services in the workplace" and the impact of spiraling costs and declining budgets on the ability of libraries and information centers to collect and provide access to information services on both a short-term and long-range basis. And, the impact of collection growth/stagnation on the information needs and information-gathering behavior of library/information center clientele:

   - Which library and information center resources can (should) be accessed remotely?

   - Which materials merit collection/retention?

   - How can lesser-needed materials be acquired/borrowed in a cost-effectively manner?

   - How can libraries and information centers develop a stronger technological infrastructure while simultaneously trying to purchase materials?

5. Service quality, or "meeting the public's expectations," and "the rising demands for public services in the environment of continual revenue shortages:"

   - See section on "Information Resources Management"

9. The application (or lack thereof of the information life-cycle on STI, and refinement of the model as necessary:

   - See section on "Information Resources Management"

12. The extent to which training programs for the staff of libraries, information centers, and agencies result in the better provision of access to information:

   - Does attendance improve staff members' service quality?

   - Which training programs are most effective, and why?

13. The extent to which performance measures for libraries and information centers can improve the quality and quantity of services provided to STI users:

- Which performance measures are most useful for improved decision making?
- How else might libraries and information centers evaluate their services?
- How successful are the programs?

14. Development, testing, and refinement of a user-access model that includes variables such as awareness, "organizational culture," "attitude toward information and communication technologies," one's own skill and level of training in retrieving information, relevance, quality, and financial resources:

- Can such a model be developed and applied to libraries, information centers, and other safety nets, and indirectly to IRM?

20. Ability of libraries and information centers to provide their clientele with lesser-needed materials from remote storage and through inter-institutional lending:

- How promptly can the materials be supplied?
- How cost-effective is the operation?
- On which institutions does the greatest burden of lending fall?
- How can inter-institutional cooperation be improved, e.g., through the use of technology?

21. The extent to which libraries and information centers meet their mandated mission, goals, and objectives:

- Do they meet their mission, goals, and objectives in a cost-effective or cost-benefit way?
- How successful are available services?
- How satisfied are clientele with the services and overall with the libraries and information centers?

24. Locator systems as "one-step information processing systems." Examine the various safety nets and information locator systems and determine how these pieces of the information access puzzle can be pieced together, thereby enhancing public access:

- See section on "Information Resources Management"

28. Perceived versus actual barriers to information access (within libraries and information centers, for instance), the extent to which physical layout of the library or information center impacts on access?

- What barriers exist, and how significant are they?
- How can significant barriers be overcome?
- Does lack of "user friendly" software and systems create a significant barrier to use and to the inclusion of a product as part of a library or information center service?
- Does information duplicate what is available from other sources? Does this matter?

Dissemination

3. "The properties of information, its impact on society, its dissemination and access:"

- What do different client groups look for in information, e.g., understandability, completeness, and accuracy?
- How should such insights be included as part of marketing and dissemination programs?
- How much demand is there for specific dissemination programs?

8. The impact of information overload on information access and use. Effective and efficient strategies for disseminating higher quality resources and for offsetting information overload, where a problem exists:

- How can information overload be reduced?
- How can ease of access be increased?

26. New methods of storage and dissemination, new systems for information and data access, and new methods of information resources management. For example, examine decision support and expert systems:

- See section on "Information Resources Management"

29. Government activities relating to quality control and information dissemination:

- See section on "Information Resources Management"

Bibliographic Control

1. The impact of the medium (type and format) in which knowledge, information, and data are presented on information access:

- See section on "Libraries/Information Centers/Safety Nets"

10. What is adequate physical and intellectual access to government and non-government information:

- What information sources merit bibliographic control, and to what extent?
- What safety nets should provide access to the sources?
- What role should information-handling technologies play?

24. Locator systems as "one-step information processing systems." Examine the various safety nets and information locator systems and determine how these pieces of the information access puzzle can be pieced together, thereby enhancing public access:

- See section on "Information Resources Management"

25. Levels of bibliographic control and the extent to which each level provides specific user groups with acceptable access to specific types of information:

- How complete of bibliographic control is necessary for different types of information?
- What level is necessary to attract more use?

- What services exist for each level, and how cost-effective or cost-beneficial are these services?

Barriers to Access

2. The extent to which quantity of knowledge, information, and data on a topic inhibit access to that knowledge, information, and data that will make a difference. Whether or not the information "glut" promotes or diminishes user access:

- Is there too much knowledge, information, and data available on a topic?

- How does this overabundance impact on use?

- What are user expectations for the information and data they might (or will) use?

8. The impact of information overload on information access and use. Effective and efficient strategies for disseminating higher quality resources and for offsetting information overload, where a problem exists:

- See section on "Dissemination"

11. The extent to which technology causes "glut' conditions without improving real access" and whether "the information glut' available through data base systems (the format or presentation of information) promotes or diminishes users' access:"

- How does the number of false drops affect access?

- How easy is it to gain access to identified information sources?

- What is the quality of the information source actually found?

16. Availability of technology in the future that can read electronic information and data of today and yesterday (The extent to which "information gaps" exist and information is unavailable to those entitled to its use):

- What information and data are being lost?

- What are the implications of this loss?

- Can (should) the loss be prevented?

28. Perceived versus actual barriers to information access (within libraries and information centers, for instance), the extent to which physical layout of the library or information center impacts on access?

- See section on "Libraries/Information Centers/ Safety Nets"

Equity and Access

15. Equality of access to government/non-government information, seeking that those needing information receive it and know how to use it (this topical area includes the free vs. fee debate):

- What information should be provided free?

- How costly is it to provide that information?

- What is the rate structure?

16. Availability of technology in the future that can read electronic information and data of today and yesterday

(The extent to which "information gaps" exist and information is unavailable to those entitled to its use):

- See section on "Barriers to Access"

17. Extent to which new information technologies are cost-effective and ensure access for people with varying backgrounds and levels of computer literacy:

- What is the learning curve? How does this impact on use?

- What support services exist? How good are they?

- How are costs contained in an evolving technology?

19. "Access to electronic data and potential trends toward loss of information access by the economically underprivileged:"

- What information do these people want/need?

- How costly is it to provide such information— cost/benefits?

- Where do these people gather their information? How cost-effective or cost-beneficial is it for specific safety nets to provide the information?

Networking

18. The impact of networks and information-handling technologies on information access, and the extent to which telecommunications infrastructures meet the need for information access and transfer:

- How effectively do these networks serve users directly or through libraries, information centers, and other safety nets?

- How rapidly do these infrastructures change, and how well do libraries and other safety nets meet the needs of their clientele for access to electronic information? What changes can these safety nets make within their infrastructure given present day financial stringencies?

23. High-speed computer networks and how they can facilitate users' access to networked information resources:

- How can the evolving networked environment best meet user information needs?

- How can the network facilitate users' access to networked information sources?

- Do the networks displace other channels for access to information?

27. "The implications of regionalism for information cohesiveness...[and] the relationship of regional communication networks to international networks:"

- What networks exist and what are they doing?

- Can these networks become part of a larger system? Have they already become such a component?

- How can such networks lessen information overload?

- What uses are made of these networks?

Technology

11. The extent to which technology causes "glut conditions without improving real access" and whether "the information 'glut' available through data base systems (the format or presentation of information) promotes or diminishes users' access:"

- See section on "Barriers to Access"

14. Development, testing, and refinement of a user-access model that includes variables such as awareness, "organizational culture," "attitude toward information and communication technologies," one's own skill and level of training in retrieving information, relevance, quality, and financial resources:

    - See section on "Libraries/Information Centers/Safety Nets"

16. Availability of technology in the future that can read electronic information and data of today and yesterday (The extent to which "information gaps" exist and information is unavailable to those entitled to its use):

    - See section on "Barriers to Access"

17. Extent to which new information technologies are cost-effective and ensure access for people with varying backgrounds and levels of computer literacy:

    - See section on "Equity of Access"

18. The impact of networks and information-handling technologies on information access, and the extent to which telecommunications infrastructures meet the need for information access and transfer:

    - See section on "Networking"

30. Standards for information and data interchangeability and use, and bringing the knowledge bases residing in many scattered reservoirs directly to users:

    - See section on "Information Resources Management"

Public/Private Sectors

22. The relationship between the public and private sectors in information provision and access, or "the balance between governmental and commercial means for provision of information from...government records:"

    - What is the role of the private sector in the collection and processing of data?

    - What is the relationship between public and private networks and document delivery systems?

    - What is the impact of privatization of information services and operations on service quality?

    - To what extent does the mosaic theory exist, and what are the consequences?

24. Locator systems as "one-step information processing systems." Examine the various safety nets and information locator systems and determine how these pieces of the information access puzzle can be pieced together, thereby enhancing public access:

    - See section on "Information Resources Management"

Appendix B

This appendix details the procedure used in the afternoon session to develop the Research Agenda. First, group participants reviewed the themes specified in Appendix A and suggested a consolidation and reconfiguration of the themes. The participants also identified sub-themes and four critical aspects: Human Resources, Quality Assurance, Cost, and Technology.

The themes, sub-themes, and aspects were laid out as a matrix with 20 cells (see Figure 5). Using the nominal group technique, each group member made three selections from the matrix. The first selection was the highest choice (3 points), the second selection become the second highest choice (2 points), and the third selection was the third and final choice (1 point).

Thirteen group members disclosed votes and the group leader tabulated the number of points that each cell in the matrix received. Following is a list of items (13 cells from the matrix) which received at least one vote:

I. Information Management

    a) Human Resources (9 votes)

    b) Quality Assurance (6 votes)

    c) Cost (6 votes)

    d) Technology (8 votes)

II. Provision of Information

    a) Dissemination

        - Quality Assurance (5 votes)

        - Cost (4 votes)

    b) Bibliographic Control

        - Quality Assurance (3 votes)

III. Access to Information

    a) Barriers and Equity

        - Human Resources (5 votes)

        - Cost (9 votes)

        - Technology (4 votes)

    b) Networking

        - Human Resources (4 votes)

        - Technology (6 votes)

Once the participants had identified the framework for the Research Agenda, they broke into four groups (Human Resources, Quality Assurance, Cost, and Technology) and reviewed the topical areas presented in Appendix A. In some instances, they amended the language presented in the appendix, and in other instances, they developed new topical areas. Each group presented the results of its discussion to the session moderator who then compiled the Research Agenda presented in this paper.

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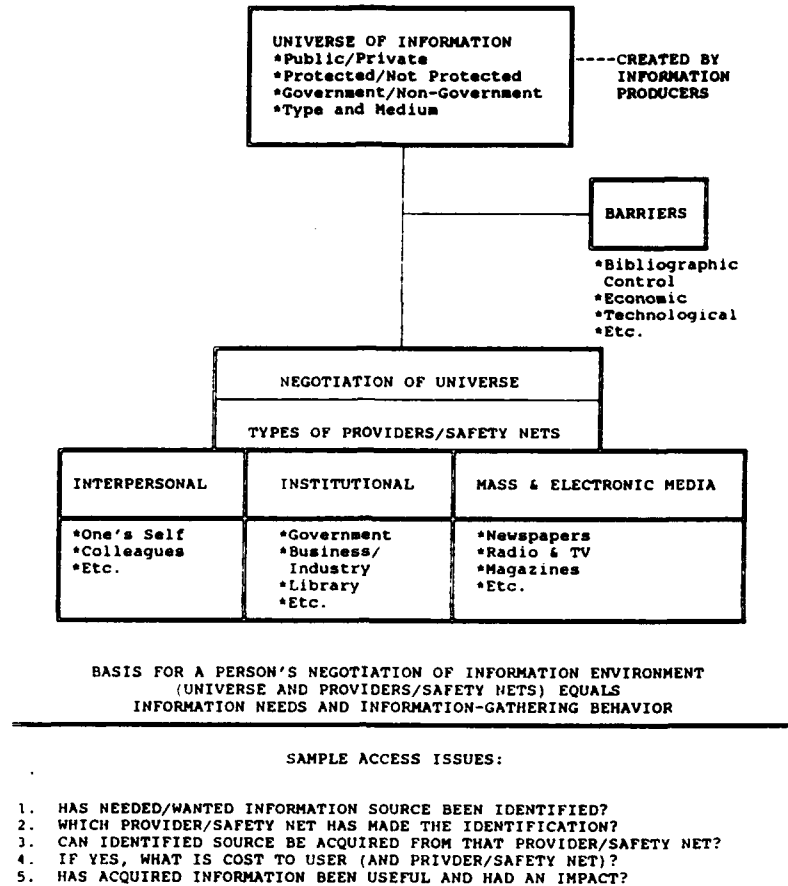
UNIVERSE OF INFORMATION
*Public/Private
*Protected/Not Protected
*Government/Non-Government
*Type and Medium

----CREATED BY
INFORMATION
PRODUCERS

BARRIERS

*Bibliographic
 Control
*Economic
*Technological
*Etc.

NEGOTIATION OF UNIVERSE

TYPES OF PROVIDERS/SAFETY NETS

INTERPERSONAL	INSTITUTIONAL	MASS & ELECTRONIC MEDIA
*One's Self *Colleagues *Etc.	*Government *Business/ Industry *Library *Etc.	*Newspapers *Radio & TV *Magazines *Etc.

BASIS FOR A PERSON'S NEGOTIATION OF INFORMATION ENVIRONMENT
(UNIVERSE AND PROVIDERS/SAFETY NETS) EQUALS
INFORMATION NEEDS AND INFORMATION-GATHERING BEHAVIOR

SAMPLE ACCESS ISSUES:

1. HAS NEEDED/WANTED INFORMATION SOURCE BEEN IDENTIFIED?
2. WHICH PROVIDER/SAFETY NET HAS MADE THE IDENTIFICATION?
3. CAN IDENTIFIED SOURCE BE ACQUIRED FROM THAT PROVIDER/SAFETY NET?
4. IF YES, WHAT IS COST TO USER (AND PRIVDER/SAFETY NET)?
5. HAS ACQUIRED INFORMATION BEEN USEFUL AND HAD AN IMPACT?

Figure 1. Overview of Access Issues.

CREATION
&
COLLECTION

PRODUCTION

PROTECTION
(where
appropriate)

RETIREMENT
* Archived
* Destroyed

ACCESS,
RETRIEVAL,
& USE

AVAILABILITY,
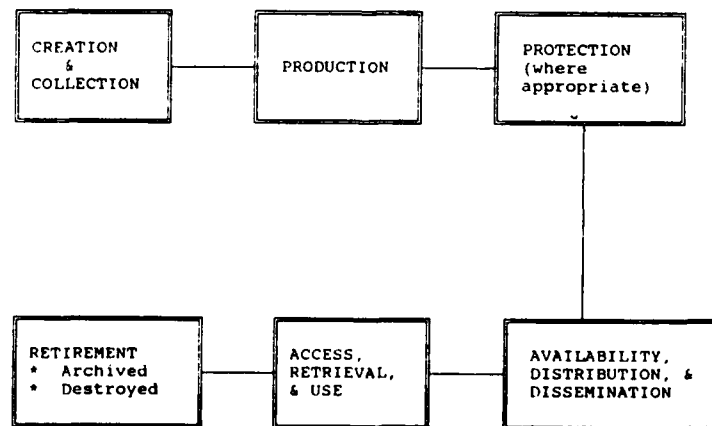DISTRIBUTION, &
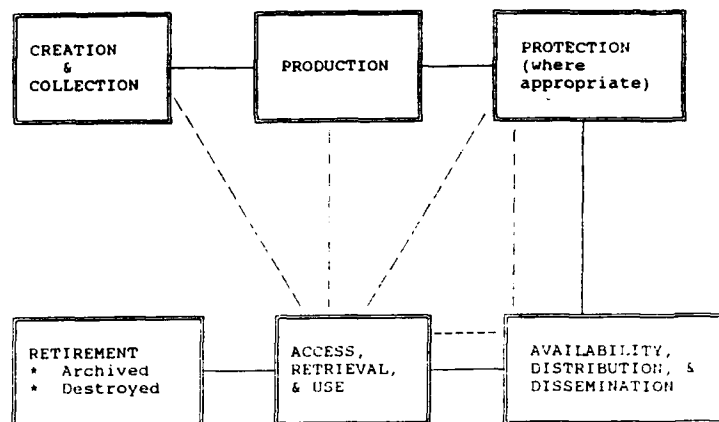DISSEMINATION

Figure 2. Information Life-Cycle.

Figure 3. Access Feeds Back to Other Stages of Life-Cycle.
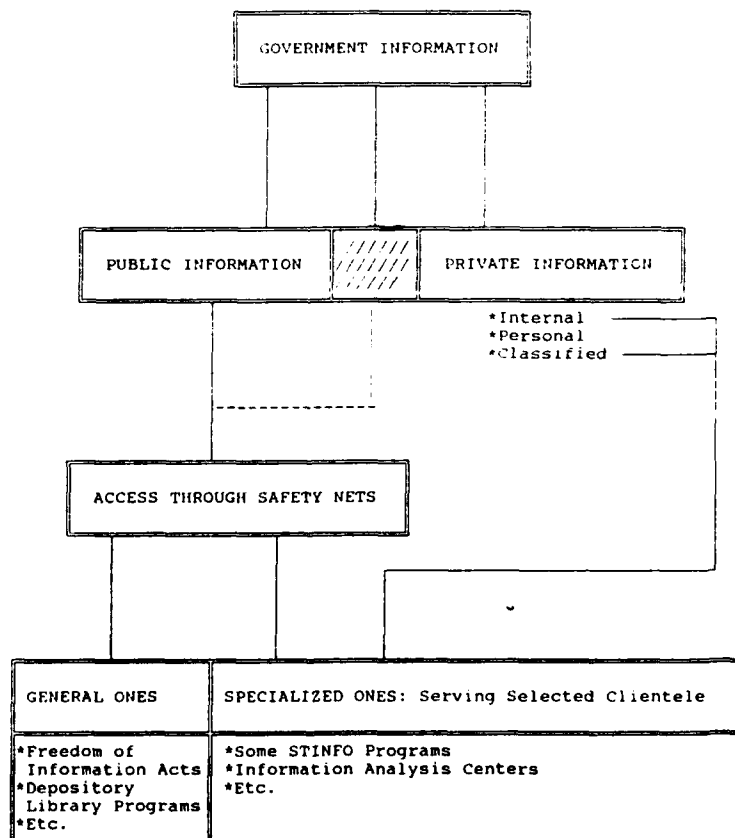
Figure 4. Government Information Safety Nets.

	Human Resources	Quality Assurance	Cost	Technology
I. Information Management				
II. Provision of Information a) Dissemination				
b) Bibliographic Control				
III. Access to Information a) Barriers and Equity				
b) Networking				

Figure 5. Matrix for Information Access.

THE ORGANIZATION AND TRANSFER OF INFORMATION

Bill Tuck
Department of Computer Science
University College London
London, England
UK

Introduction

The objective of this workshop is to develop a research agenda for management and policy issues relating to scientific and technical information. The intention is not only to inform but also to elicit recommendations for further research and study. In particular, it will be important to determine just what it is we do not fully understand, and also to assess the effectiveness of our programs. These two concepts—'understanding' and 'effectiveness'—form the underlying themes of the following paper. They are not unrelated: it is clearly a possibility that our programs may be ineffective because we do not fully understand the issues on which they are dependent. Conversely, improving their effectiveness will almost certainly require more detailed knowledge of the underlying dynamics. The class of problems toward which this paper is addressed is concerned with the organization and transfer of information. What barriers exist to the effective retrieval and transfer of scientific and technical information? And how does one ensure the quality and integrity of that information? These are complex issues only partly addressed in the present paper, which is intended to provoke discussion rather than provide detailed solutions. Input to this paper has come from a number of different sources. Historically, it must be recognized that the problems posed are not new. It is of interest therefore to record how earlier information specialists attempted to deal with these same problems—and to assess their success, or otherwise. In 1946 the Royal Society conducted just such a debate, and the documented account is a useful corrective to temporal narrow-mindedness [1]. The same debate is also going on at the present time. Recently, the R&D Dept. of The British Library itself carried out a forecasting exercise to look at the possible effects in the medium term of technological and other forces on the whole of the information field. This study (published in 1990 as "Information UK 2000") explored likely trends in the way that information would be generated, handled, stored and used in the period up to the year 2000, and the likely effects on the library and information communities of the United Kingdom [2].

The purposes of the UK 2000 study were:

- to raise the level of awareness within the library and information community of the potential for change and innovation

- to assist policy and decision making in the medium term

- to help in planning future research.

At the present time, the UK Office for Library Networking (UKOLN) is involved in determining the potential role of communications technology in the provision of information services [3]. One outcome of this work is to be an agenda for research. Another is to be the formulation of policy on library networking. To maximize the effectiveness of libraries, a high degree of cooperation over the delivery of information services will be required, and this can only be provided by an increased reliance on network technology. Research is needed both to justify and to implement this technology. In addition to these three primary sources, there is ample evidence within the library and information services literature of concern to debate the issue of research priorities. Driven largely once again by the impact of new technology, there is a desire to understand its implications and to assess its potential for improved services. These debates have provided much of the input to the present paper and many of their conclusions are presented here in summary form. At the same time, however, I have been concerned to give a more personal account so as to keep the discussion alive. This may be in some places at considerable variance from the accepted view, but at least it should help to remind us that prediction is always a notoriously difficult art [4].

Historical Background to the Problem

Early in 1941 a proposal was put to the Royal Society to hold an "Empire Scientific Conference" to which representatives of all scientific disciplines and from all parts of the British Commonwealth (or as it then was 'British Empire') would be invited. With UK Government approval and funding, the Conference took place over a three week period in June/July of 1946, as soon as practicable after the ending of World War. It began with a formal opening addressed by HM The King at the Senate House of London University on 17 June; moved via University College London, Oxford and Cambridge; returning to London for a closing session three weeks later on 8 July. My father-in-law was present at this great gathering and recently passed on to me the Proceedings published by the Royal Society—they run to nearly 1600 closely printed pages.

The atmosphere of the time was one of great optimism and of concern to amend the ravages of war. Within the British Empire this concern was reflected in the desire to share knowledge between all member states who had shared the burdens of the conflict that had just ended. Much of the debate was concerned with establishing research agenda for the various scientific disciplines involved, and also with the more general questions of how best to organize a cooperative effort. The particular question of information dissemination was addressed at some length, with over 20 papers presented. The most radical suggestions came from the noted biologist J.D. Bernal. These are interesting (and relevant) enough to be worth quoting at some length:

> "There can be no doubt that the growth of scientific effort in the world has made the task of proper distribution of scientific information a critical one, in that, whereas the annual increment of new knowledge in the whole field of science and in any particular field is rapidly increasing, the capacity for assimilating knowledge of each individual research worker, is absolutely limited." "The changes required are those which should provide for the worker in science the maximum of information relevant to their work and the minimum of irrelevant information; that is, it should aim at efficiency and economy. This can only be done by better organization of the production and distribution of the basic unit of scientific publication—the individual paper. This can be achieved without any interference with the autonomy and function of scientific publishing bodies, such as scientific

societies, by the formation of an adequate distributing agency using modern methods of reproduction and distribution." "The distribution of papers and abstracts could be undertaken by a number of central distributing offices, set up jointly by scientific societies and other publishing bodies in each country. The individual paper would be sent in, accepted and edited by the scientific society as is done at present, but it would be printed and distributed by the central office to individual members of societies in its own country and to corresponding distributing centers in other countries."

In other words, the solution proposed was a sort of central agency that would collect, from the scientific societies, all papers to be published. This agency would then be responsible for redistributing them to individuals, either by standing block order or on request.

In some respects, the suggested operation parallels that of the present services of the British Library's Document Supply Center (DSC), and it may well have been one of the instigators of this development. More generally, however, in spite of the considerable enthusiasm for a coordinated publishing center, it does not appear to have been carried further. No simple technological solution was found to the information explosion, despite high hopes for the new wonder medium of microfilm.

In fact the solution, if indeed there was one, lay in a completely different direction. It is remarkable that in the hundred or so pages of the report devoted to this topic the role of commercial publishing organizations, as opposed to scientific societies, is never mentioned. With hindsight it is now possible to see how publishers, working for commercial gain and not just intellectual idealism, were able to fill the gap. Technology made publishing easier and this, coupled with clever marketing, allowed the needs of individual research workers to be met without necessarily swamping them with irrelevant material. The growth of specialized journals replaced the portmanteau volumes of rather amorphous learned societies and the invention of the photocopier rendered obsolete the distribution of article off-prints. In addition, of course, one should not neglect the importance of the indexing and abstracting services, coupled later with the technological advances of online databases—though here again it was often the commercialization of the service through the efforts of the distributing agents, such as Dialog, that made it work, not the technology per se. The situation as outlined by Bernal is, of course, a perennial one: Too much information; too little time to read it all, and some rationalization required to relieve the burden and make the process more efficient. More recently, however, a new problem has emerged, or rather the old problem has re-emerged in a new guise. The explosion of periodical titles, rising subscription costs and falling real incomes means that libraries are finding it increasingly difficult to cope. The extent of this problem and its implications for research were presented in a study carried out for the British Library [5], and have also been pointed out by many other authors [6]. One of the suggestions of these reports is that reduced library finances are beginning to have significant effects on research. Expenditure on periodicals, while it has been increased substantially in recent years, nevertheless still lagged considerably behind the recorded increase in periodical subscriptions. The usual response is to cut periodical subscriptions; while at the same time the number of periodical titles being published increases remorselessly. The economics seem paradoxical, but the net consequence is that there is a decreasing likelihood of finding any particular article on the library shelves. This, it is suggested, has lead to:

- increased use of the inter-library loan system

- increased use of online search facilities

- less rigorous searches

- increased tendency to bypass the library

- inability to place as much reliance upon browsing for meeting information needs as formerly.

Given that it is unlikely that the financial resources of libraries themselves will ever be increased sufficiently to overcome this problem, what is needed is a joint effort between publishers and technologists to harness the two sides to provide the right balance between a market-led and technology-led approach. This problem, clearly, should form one core part of any research agenda on the organization and transfer of information. Unfortunately, it is questionable whether we yet have a good understanding of what the problem is, with the result that many suggestions for its solution can seem rather fanciful. One approach lies at the heart of what has become known as electronic document delivery. Proponents sometimes take the view that if only we throw enough technology at the problem then the quest to automate the business of getting source documents should be solvable. In practice, it is rather more difficult than this and much research remains to be done.

Cleveland (1991), in a report carried out for IFLA, comes to the conclusion that:

"integrated document delivery systems will form an essential part of the electronic libraries that may emerge as the principal source of information in the coming decades. These systems will increase the efficiency with which primary documents can be provided to end-users allowing them to select request and obtain documents directly from their local computers. Such systems will be necessary to correct the growing disparity between bibliographic access and document supply, and to increase access to an exponentially expanding body of information." [7] But, the report goes on to say, the integrated document delivery system will not appear rapidly in a revolutionary manner but will most likely develop slowly "in an incremental fashion out of existing library systems" (Lynch, 1990, [8]).

The reasons for slow evolution are:

- the need for an electronic corpus of literature to form the basis of an electronic library (requiring retrospective conversion of core works from paper and widespread use of standards for representation of electronic documents)

- the need to resolve copyright issues

- the need for mechanisms for bibliographic control

- the problem of resistance to change from within institutions

- the standards required for linking abstracting and indexing records with the primary material

- the need to develop a communications infrastructure

Clearly, the research agenda for such an enterprise will be substantial.

The New Vision

At this point it is interesting to compare Bernal's suggested approach outlined earlier with that of a well-publicized modern counterpart. In a recent issue of C&RL, Rogers and Hurt (1990) propose a radical new vision of future scholarly communications in which the full power of online media and computer communications

would be utilized [9]. Scholars would begin by "publishing" their articles for general comment on the electronic network, which would also provide means for reading other publications. After an article had been in the system for 6 months so that comments could be collected it might be revised by the author and flagged for review. Review boards would be the governing agencies for each scholarly area, with members nominated and elected by participating institutions. Such boards would perform the functions now undertaken by editors of scholarly journals, essentially to ensure a measure of quality control on the final product by attaching a rating value to each article. Such a system might provide many benefits to colleges and universities, including the economic advantages of savings on periodical subscriptions, storage space and processing time. An even more important role is seen, however, in the way such a system would influence faculty appointments. Instead of hiring and promotions being effectively determined by the opinions of journal publishers and an inner circle of referees, universities themselves would be empowered to choose the members of the review and management boards:

> "The reviewers chosen by such boards could be very different from the people now used by journals if the selections were not based on the buddy system or 'old boy' connections. The system thus could provide better information for universities to make informed personnel judgments."

This, of course, introduces a whole new dimension to the question of electronic document delivery. The issues are seen as not just technical or economic ones, but as political, in that they affect the distribution of power within and between organizations. Similarly, in many respects a political agenda also underlay the reforms proposed by Bernal in his 1946 paper:

> "If such a scheme could be agreed on by representatives of scientific societies in the British Commonwealth, United States and other principal scientific countries, it would offer considerable economies in publication. It is suggested that the proper way to pay for such a service is to treat it as a common scientific service to be borne on the general budgets of the countries or through their subscriptions to UNESCO. At present, when the vast majority of scientists are working in directly or indirectly Government subsidized laboratories, it seems both illogical and wasteful to make them pay individually for an absolutely essential part of their work, and the taking of the burden of publication costs from the societies and individual scientific workers could only lead to the enhancement of the more purely scientific activity of both."

In both cases, the weakness of the proposals comes from their assumption of a rather idealistic state of affairs and the desire to impose a 'managed economy' on the world of information. In fact, unlike the situation in 1946, a substantial (and probably increasing) proportion of scientific work is not now carried out in government-subsidized laboratories, any more than scientific publishing is the prerogative of learned societies. The world has become an altogether more complicated place and simplistic approaches to information transfer are unlikely to square with reality. This is not to say that systems such as that proposed by Rogers and Hurt, or by Bernal, would have no place in the future of scientific publishing. Variants of both, in fact, already exist and show every likelihood of increasing in importance as the supporting technology becomes more capable. Electronic journals and network publishing will inevitably develop from their current embryonic form to create a significant component of the future information world. But what must also be taken into account is the influence of markets and alternative technologies in providing competing modes of publication and information transfer: the Internet is not the only network; scholarly journals are not the only form of scientific publication; and the government-funded research lab is not the only way of generating scientific progress.

Examples of alternative information sources must include the patents literature—a resource surprisingly neglected by non-commercial research institutions. Furthermore, this is a corpus that is already very largely in digital form—albeit scanned images, rather than SGML or ODA. Indexing and abstracting services are likewise highly developed. In addition, it is not subject to the same copyright restrictions as other research publications. For all these reasons it would seem to make an ideal candidate for electronic network publication. At the same time one should not underestimate the scale of the problem. The Japanese Patents Office began a project to transfer all the world's patent information to electronic storage in 1984. At present this runs to over 25M documents on around 2000 2.6GB optical disks loaded into 60 jukeboxes (from figures published in March 1990). This store includes image data from the EPO and USPTO as well as the JPO. Local access is provided to some 250 workstation/terminals by a 400 Mbps local area network. Remote access from regional offices will become available as the high-speed wide area networks develop. It is worth noting the very high bandwidths required in order to achieve a sub 1-sec page flip rate on interactive access. For simple document delivery (such as 'within the hour' turnaround) much slower speeds would suffice. Another Japanese project on electronic document delivery is being launched by the national telephone company NTT. Together with a consortium of banks and publishing interests, they have begun to make available a database of document images compiled from some 37 newspapers and 141 magazines. There are now over 2M items in the database, covering many diverse fields (Politics, Science, Culture, Society, Industry). Each article has a full bibliographic entry, together with the document image. Around 250 persons are involved in data input, which requires the images to be scanned, clipped electronically and entered along with the bibliographic details into the database. Access is by subscription, giving a daily bulletin matched to a user profile, or from an online search and request. Delivery is by standard Group 3 fax. The storage technology in this case involves 25 jukeboxes on a LAN, each with 16 disks and each disk with 3.6GB of data, giving a total of 1.44TB [10].

Clearly, the storage requirements for such databases are substantial. For comparison, the ADONIS database in its early experimental form generated nearly 80 CD-ROMs from just over 200 journals in two years [11]. This gives a rough figure of 10GB per 100 journals per year. Compression techniques have improved somewhat since then and they are now able to get upwards of 10000 pages per disk instead of the 6000 previously. On this reckoning, 10000 journals will generate around 1TB (1000GB) of data per year (in page image form). Extrapolating from these figures, one can conclude that the approximately 50000 serial titles taken by the British Library Document Supply Center would correspond to 5TBs of data per year. This is of the same order as the total current storage of the JPO. While this may be beyond our present technical capabilities, the rate at which technology is advancing means that a point will be reached sometime in the future where it does become possible—in other words, the exponential growth in the rate of publication is more than matched by the hyper-exponential growth in storage technology.

The problem, however, may not really lie there. In fact, there is little point in storing such vast volumes of data electronically if it still cannot be used effectively. And here we are doing less well. Jean Voge, in a recent article in ITU's Telecommunications Journal comments that "In 1985, not more than 5% of the information in Japan was used. In 1970 it was 11%.... Information is not as useful as it once was."

For some time now it has become apparent that the service sector of the economy has been left largely untouched by the productivity tools it has been offered. For example, a recent article in the Economist newspaper (August 1991) pointed out that in the 30 years to 1990, the cost of computing power fell by a factor of 6000. By 1989, U.S. companies unleashed a binge of spending to equip themselves with enormous information processing power (with the buying of newer and better computers accounting for over 51% of durable equipment expenditure), but compared with manufacturing productivity, which managed to keep up a respectable growth of some 3% on average per year, productivity growth in the service sector stagnated. The crucial point is that the service sector of advanced economies like the U.S. is now the dominant part of the entire economy—according to some commentators, at least one in every two workers is now an information-based worker:

"The developed world in the next century will be relying increasingly on service sector economies. Failure to increase productivity here could mean that service-based economies could rapidly reach a crisis point and decline. The computing and communications industries will have to grapple with this, possibly their greatest challenge" [12].

Creating a Research Agenda

The issues addressed so far—technology, politics, economics—are basic to both understanding and making more efficient the organization and transfer of information. Practical steps towards drafting a research agenda would need to take account of these various factors. Within the UK itself there have been a number of initiatives to create a research agenda for the library and information services community. Two, in particular, have already been mentioned, but deserve a more detailed discussion, namely, Information UK 2000 (British Library) and UKOLN (the UK Office for Library Networks). As mentioned earlier, Information UK 2000" was an initiative of the British Library R&D Department. In a wide ranging report it sought to gather all the background evidence for predicting change in library and information service requirements over the next decade. Factors of importance included the technological environment, the communications environment, publishing, the demographic background, the educational environment, the role of library and information service professionals and library services themselves. Within the 'recommendations for future action' a number of research themes were suggested. These included a systematic investigation of new technologies and their applicability to information services.

Examples are:

- parallel processors—how competitive will they be with current techniques and what kinds of software will be needed to use them effectively?

- X-terminals—how valuable will the technical advantages of these terminals be in relation to present equipment, and as a standard for user interfaces?

- local area networks—these are becoming widely used but little is really known about what they are being used for, and how effectively

- software development—at what point should PC users be prepared to switch from MSDOS to Unix and what will the advantages be?

- use of Document Image Processing for electronic archives requires study, as does he conversion of paper records to electronic form

- content-based retrieval from image and sound databanks

- legal aspects of electronic publications

Research in the field of professional publishing was also identified as a potentially rich field for research. Some suggested themes include:

- control of research publication—it allows this to be taken over by the creative academics; the implications of this for copyright legislation needs to be monitored

- multimedia publishing—growth is confidently predicted, but the economics of the process need to be studied

- data for the information industry—as the information industry grows in size and importance in the next decade, it will generate a keen demand for accurate market data on trends in growth of different kinds of information services and media

As well as research themes, there were many other recommendations on such matters as policy issues, training and the implications for library and information professionals:

"As demand for computer-based information services grows, from an increasingly discerning market, users' expectations regarding quality (especially in relation to accuracy and currency) will inevitably rise." [2, p. 262] Partly as a response to the UK 2000 project, the UK Office for Library Networking (UKOLN) was established with funding from the British Library R&D Department in late 1989 (although a Project Officer was not appointed until April 1990). It was set up at the University of Bath in parallel with the Center for Bibliographic Management with whom it shares administrative support [13].

The general remit of UKOLN is to encourage and support the use of networking by the UK library and information services community:

"The primary goal of the UK Office for Library Networking is to enable the production of a common or cohesive strategy for the use of networking by the UK library and information community."

An important objective of the UKOLN program was to determine an agenda for research; to determine what needed to be done in order to make best use within the library and information community of the emerging network technologies. To this end a series of workshops on various aspects of the technology were held throughout 1990. Topics discussed have included networking and the bibliographic record, networking and public libraries, network publishing, document delivery, the virtual library and the development of standards. Output from these workshops, in the form of policy recommendations and a research agenda, will shortly be published.

A 'Radical' View of Technology Change

Notes that were originally submitted by the author as a contribution to the Information UK 2000 project may be useful background to some of the themes explored in

the present paper [4]. In these notes the main thesis was that, in the last analysis, it is technology coupled with the marketplace that drives the changes, rather than the wishes of information professionals, no matter how well-intentioned. Technology (as the outcome of R&D) on its own is not a sufficient predictor of change. Nature is wasteful, and much that is technologically of high quality fails to catch on in the marketplace. The factors determining technology takeup therefore deserve research in their own right.

Experience of successful developments over the past decade (e.g., CD-ROMs, PCs, RDBMSs) suggests that the principal market factors that determine technology take-up are mass-market consumer electronics and constraints on skilled labour. A technology can therefore succeed (ie. show a reasonably high take-up rate) only if either it can ride on mass-market appeal, or it can show a high increase in productivity (particularly of skilled labour). These factors give some basis for the analysis of many new technologies in order to assess their potential impact on information services. The important ones on this score look to be ISDN, HDTV, CDI, CBT, DBS, FM and EDI (a glossary is appended to the original paper). On the negative side, it is also possible to identify a number of new technologies that seem burdened with either (or both) high complexity or high cost. Such technologies will only be supported if the associated value is also perceived to be high. One particular example of a technology that is likely to have considerable impact on information services professionals is the coming availability of 'high-speed' (i.e., 64K bps rather than 2400 bps) access to online services as a result of 'mass-market' ISDN. This will enable much more 'user-friendly' interfaces to be designed, opening them increasingly to end-user access. It must be remembered that much of the work skill of the information intermediary was necessitated by the limitations of a particular technology—low-speed, high-cost, remote access to online databases requires great skill in manipulating a terse and arcane command language in order to make efficient use of the limited and expensive bandwidth. Increased, low-cost bandwidth threatens to make the role of the intermediary redundant, since it enables interfaces similar to those for CD-ROM to be implemented. Like the lift attendants of an earlier age, a quite small change in technology (the automatic high-speed lift) can render a whole class of employment redundant. There will, nevertheless, still be a need for 'high quality' searches, for which a correspondingly high level of skill will be required. As with the development of computer software, we need to take into account the quality level required and not match every search request by a uniformly high measure. Information, like any other technology, can be 'over-engineered', which is a wasteful strategy. Research is therefore needed into 'quality of service' requirements. What then are the areas of research that need to be developed in order to cope with these anticipated changes, and to further those two basic criteria that underly our agenda, 'understanding' and 'effectiveness'? The next section presents a list of proposals intended to act as a 'strawman' for purposes of discussion. It takes as its basis the point of view presented in the notes on the 'Technological Imperative', but also draws to some extent on the recommendations of UK 2000 and UKOLN reports.

A 'Strawman' Agenda

As the heading suggests, this is intended to be no more than a target to get the debate started. The order is from the general to the particular, from the somewhat vague (What is information?) through the very general (What is a library?) to the specific (How will new technology affect librarians and users' demands on them?) and on down to the hard particulars (What will it cost, and how can we market new services?).

Communication and the Exchange of Information

There is a basic requirement to come to a better understanding of the role of information within the communications process. In a sense, the transfer of information "MI" is "M" communication. There is a need for cross-cultural studies on the use of information (comparisons, for example, of information transfer within Japanese compared to U.S. or UK firms). In the same way, there is a need for comparative studies of the use of information within different working groups—academic research and industrial research, for example, or between workers in different industries or professions. On the basis of such studies it should be possible to produce better models of the interaction between information and communication. Finally we should come to a better understanding of the role of technology (both current and potential) within information exchange, by studying the use by researchers and others of the communication networks for information gathering and dissemination.

The Changing Role of the Library/Information Center

What is an information center or library? What do they actually do? In the evolution from 'acquisition' to 'access', the library moves from being a repository to being a facilitator, providing the point of access to a wide variety of information sources. It also moves towards being a primary agent within the communications domain: "In the same way that a computer is just a buffer on a data channel, a library is a simply a buffer on an information channel." In this model, the perception of what a library is for, changes. It becomes much more like a communications switch than a databank. Such a change needs greater understanding of the customers' communication requirements, as well as of their information requirements. In other words, there is a need for more research into the role of the library within the communications (rather than information storage) domain. There are analogies here with the telephone network. Generally speaking, the telecomms carrier has no interest in the content of telephone messages. Its role is simply to facilitate the communication between parties and to provide additional resources (such as directory services) when required.

How do These Changes in the Role of the Library Affect the Kinds of Skills Required of Library Staff?

There will be a requirement for an increase in user-training skills, from access skills to communication skills (such as Wordprocessing, DTP and 'how to publish'). The inevitable question will be whether the library is the natural focus for training in communications skills. The argument is that new technology makes it so. The organization and management of novel kinds of material will create additional demands. For example, in college libraries there is an increasing demand for the library to act as manager of exam papers, reading lists, CAL packages and other course material. Print-on-demand books and other electronically derived resources will increase this load. Research is also needed into the best way of handling non-book material, its costs, its effectiveness, its impact on library resources.

The Organization of Information: Using Technology to Provide Better Methods for Indexing, Encoding, Storing, and Delivering Information.

This is the obvious focus for much proposed research on information. Without consideration of the larger context, however, it can be rather unproductive. Many research topics concerned with the technology of information organization and transfer suggest themselves, including:

- analysis of the costs of cataloging

- techniques for the retrospective digitization of source documents of various kinds

- novel encoding schemes for bibliographic and documentary data

- the costs and benefits of network publishing

- the role of the telecomms and cable companies in the information marketplace

- the role of Standards

Publication and the Role of the Library Within the Funding Cycle

This area is partly directed at raising the profile of the library or information center. With an increasing trend towards funding institutions (or departments—or even individuals) on the basis of productivity, will come an increasing concern for quantitative measures. Information specialists have unique skills in this area:

- quality control, bibliometrics

- cost control on scholarly publishing

This role, in turn, carries political as well as economic implications and there will be a strong need to consider ways of overcoming barriers to access, including

- user education

- public awareness

- service cost analysis.

Marketing Services: Designing and Implementing Information Systems That Meet the Needs of Specific Information User Constituents

- investigation into ways of using new technology to create new services

- trade policy for cross border information flow

- copyright and revenue generation from network publishing

Discussion of the Strawman Agenda

This report is a transcript and summary of a discussion based on the 'strawman' proposals outlined in the previous section. Many of the original questions were modified during the discussion.

1. Communication and the Exchange of Information

1.1 Investigate the role of information within the communication process

1.2 Cross-cultural studies on the use of information

1.3 Comparative studies of the use of information within different working groups (scientists vs. engineers, for example)

1.4 Construction and validation of abstract models of the interaction between communication and information

1.5 Technology and information exchange: how do researchers and others use the networks for information gathering and dissemination?

Firstly, in discussing the question of a research agenda are we dealing with research for its own sake or research with a specific application in mind? We should consider both. The risk of targeting it to a specific application is that something important might be missed.

The general role of information within the communication framework is probably too general a concept to begin analyzing. Nevertheless, sociologists do make general models within their own domain of "communication." Can information science learn anything from this?

Mass communication vs. Stored knowledge: Within IS the common base is information retrieval rather than communication as understood by social scientists.

Communication also requires understanding, but information itself can exist independently of any communication—one example is that of a piece of mathematics which might be proven but exits only within a very restricted domain prior to its being understood and appreciated by a wider community.

Taking this same example, is there any way of studying the process of information dissemination, or "knowledge diffusion," particularly within an electronic environment?

Yes, this is possible, and the example is the study of how electronic mail is being used by different groups to communicate. What is the methodology for studying such things? Does this methodology already exist or must we invent it?

Probably not as quite basic techniques (of questionnaires, interviews, etc.) would be sufficient, at least for an initial (and very applied) study. But even at this level there is a need for such a study.

Adding value to the communication and to information: (see, for example, the book by Taylor "Adding Value to Information Services") This prompts the question of how can the new technology help us to add value to the information services, and how can we encourage or train the information professionals to add value to IS?

Communication and Understanding: The individual may not understand what is being communicated; the need is for adding value by creating understanding. Without understanding there is just the transfer of data.

One problem for our information services is that much that goes on is seen as just the transfer of data. It is important that it be recognized that adding value to that data is what turns it into information.

Data, Information or Knowledge: If you are transferring knowledge then there are four levels that need to be considered: Knowing, Understanding, Practicing (applications), Lifestyle. These can be combined in many different ways.

We can also add to this set of four concepts: Technology Transfer and Usage, to complete a kind of cycle in the whole process of information and communication.

Summary

The general conclusion is that "communication and the exchange of information" is probably too large a concept to be very meaningful. Even so, the ideas of "value added information services" and categories such as "knowing," "understanding," "practicing," and "lifestyle") already go some way towards the creation of an abstract model within which many specific aspects of IS can be discussed.

On the more specific question of comparative studies of the use of information within different groups, (occupational groups or cultural groups, for example) there was also considerable discussion. Valuable work is already being done in this field (e.g., the Knowledge Diffusion

Project) and it might be useful to try to build on this by adding in the question of information transfer.

User Needs and Comparative Studies

Such a study needs to be based on a sound theoretical basis, taking into account the environment. Engineers do not have the same needs or information seeking habits as scientists, nor would engineers in Portugal, Netherlands or the UK necessarily have the same methods—hence the need to take account of environment. To what extent are these differences the product of training, and to what extent may they be inate factors due to personality or some other psychological variable?

There is a strong suggestion that it may not be simply due to differences in training (or at least in formal training) but has to do with the way the individual "acts in the world."

There is considerable evidence that engineers may be very inefficient in their use of information services. The example of the use of patents information is one that has been relatively well documented. What are the reasons for this?

Traditionally, our information systems are often designed for academics rather than practitioners. This may be one reason for the reluctance of practitioners (such as engineers) to use them. This opens the question of how they might be better designed for the use of practitioners.

Part of the problem may be that our current methods of indexing do not use terms or categories that are appropriate for engineers, say. A simple example is the difference between "hammers" and "impact devices"— engineers would normally search under the more general term. Another is the difference between Chemical Abstracts and Beilstein—the practitioners find the latter form of information considerably more useful than the "raw material" of the former. Validated information— or "metadata"—is the kind of concept introduced here. The discipline of Cognitive Psychology will have a useful contribution to make to studies of this sort, as they are really concerned with looking at how people think, or solve problems.

Engineers are inherently suspicious of unsubstantiated data. Metadata must therefore be careful to include references back to the validating sources so that engineers can see the research that actually went into providing the data. Beilstein, of course, does just this—by including citations back to the original research.

There may be differences not only between cultures and occupations, but also between the same kinds of individuals in the same kinds of jobs, but in different organizations: engineers in large organizations are likely to have different information needs and different information seeking habits to those in SMEs.

There are of course other groups who need information—such as research project managers, for example. Are the needs of these being adequately met by current services? And if not, how can their needs be better served? What additional kinds of information could be included with the citation to add value?

There is also an "individualistic" dimension to information that needs to be taken into account here. While information production or provision may be quite general, its absorption is individualistic. In this sense it is rather like education: We have mass education, on the one hand, but the absorption of learning is individualistic.

In addition, the process of information transfer is multifaceted. As one goes, for example, from the programmer to the network provider, then the retrievalist, the researcher, down to the research doctor and then the clinical doctor (to get away from the scientist—engineer example) what is "data" for one phase is "information" for the next. For example, the retrievalist does not need to understand the meaning of what is retrieved—the citations are just data, which only becomes meaningful information at the next stage, where it is passed on to the researcher. Therefore, we cannot talk about "information" or "data" without characterizing the point of view from which it is being taken. For this reason, it is difficult to talk . such things as culture and environment without also carrying the point of view.

Summary

This area is probably a fruitful area for research, but almost certainly overlaps with "User Studies" to a considerable extent. Nevertheless there may be issues specifically concerned with information transfer that can be identified within this general area.

2. The Changing Role of Information Services

2.1 What kind of thing is the information center or library evolving into?

2.2 From "acquisition" to "access", to "information management": how are information services evolving?

2.3 What part do information services play in the communications domain?

2.4 What part might they be called on to play as communications technology evolves?

The intention with the original questions was to determine how the library was evolving in the face of new technology and the demands for new services. There is general agreement that focusing on the "library" or "information center" as a physical "place bound" organization may be inappropriate, and the more general term "information services" would be preferred.

Information Management

Instead of thinking just of "information science" we should be thinking of "information management" in general. Also, we should not confine this to be just within the walls of the organization but open to outside services as well.

A prior question is whether the role of the information service is actually changing, as we seem to believe, or even whether information is yet seen as or recognized as a strategic resource?

Question: What can one say about the relationship between "publication services" and "information services." Within many organizations these roles are becoming interrelated? Is the analysis of the respective roles of publication and information something that therefore requires study?

On this question, companies produce products and services and also knowledge in the form of patents. But publication and patents may be in conflict with each other—one may be trying to disclose information, and the other to obscure it.

Perhaps one should be making the definition of information management much broader. Some organizations, for example, take a very much broader view—to include reprographics, publicity, etc, as also part of the domain of info management. This could be called the "leading edge" of the information services.

At the same time, however, there is a trailing edge of very basic services which must not be lost sight of. There is still a very great need for increased appreciation of the fundamental role which books and journals can play within the information service. This entails a continuing program of education and training.

We also need to consider the "non-users" of information services. Why do they not use the service, what can be done to make it more acceptable? This is clearly a potential area for research.

Is the connection between the library and information resource management (in terms of "records management") more important perhaps than its link with "publishing?"

What is happening is that we have a "competition for space" between the professions, as analyzed in the book "The System of the Professions" by Andrew Abbott. This sees the professions as operating in a competing environment.

Are computer analysts, for example, going to take over the tasks of information resource management? On the other hand, what is it that they can't do, what is it they are not aware of?

In this respect, research is needed to define what is different or unique in the skills of the information professional, and what skills are needed in the general area of concept analysis or in going exterior to the organization to find information.

There is a very general question of trying to determine the role of the information service within the new communications environment in which it is beginning to find itself.

In fact there is a strong argument that the user has changed already. We could investigate how fast and how far the user is already bypassing the information service or using alternative routes, or what might be done to retain them.

In some sense, however, all that has happened is that the information center is no longer "place bound" but has become much more diffuse—in other words, the user has not left the library but just left the building.

There is a lot of hidden complexity in the concept of "user". Within the general area of "user studies" we need to consider a large range of issues such as user needs, information seeking behavior, the role of information service as an educator, as well as the actual use that users make of information.

In some respects, however, the role has not changed very much. The real questions may be: What is the technology mix that I have to offer my clients, my users? There is much to be said for the idea that we are "pushed by theory, pulled by technology." This is really the only way of acting or reacting on that. In the future we may have different kinds of libraries—from pure electronic to pure paper.

There is a general awareness of an imminent disaster in the area of library funding. This is partly due to the problem of technology pull. It has to be recognized that the database is only a tool. To the user, how he gets his data is immaterial. Older scientists do not use the computer databases, but prefer sources such as Beilstein and the other bibles. He hates getting data from the little screen and finds the absence of browsing a constraint on creative style and needs the stimulus of print copies. Younger scientists, on the other hand, never go to the library but tap into it all from the network. This is beginning to create financial problems for the library. There are moves towards cutting journal subscriptions. And next it will be books. Libraries may have to find ways of combining resources, or undergo other radical changes in the way they are organized. Part of the problem is that cost benefit analysis of the library is a very difficult thing to do. Perhaps this is itself a problem for research, to come up with ways of measuring the effectiveness of libraries as a strategic resource.

The other issue it brings up is to find ways of measuring the effectiveness of different approaches to information gathering (e.g., traditional vs. electronic) in respect to the creativity of research scientists. Is it true that something is lost when you cant simply go into the library and browse?

The communication process is a system of clients and servers. The library is one server within the system and there will be a lot of others. In our research agenda we should also look at the role of the clients, at users and their personal information systems, and at the interaction between these clients and the servers. This will depend very much on the field of application—e.g., topological searching in chemistry, or graphic pattern searching in patents. We should also look into other fields where we might improve the communication process between the clients and the severs.

There are potential difficulties in looking just at new methods of searching. Online is just another tool. In any real application there is a need to analyze the user's query and apply offer a complete range of services to answer it—from online, to asking the chap down the corridor. We have to ask whether there really is a new means of searching, or whether we are in danger of being led too far down the simplistic online path, neglecting perhaps more traditional methods that could be much more efficient.

The basic need is to investigate just what technologies are most cost-effective in providing solutions to users' inquiries.

3. Impact of Changes in Information Services Upon the Professional Skills of LIS Staff

3.1 From "acquisitions management" to "access control", and then to "communications facilitator"—what new demands do these changes place upon professional skills?

3.2 From books to videos, from online to CD-ROM, from information resource to online multimedia conference facility—these changes in content will also create new demands on LIS management.

3.3 The management of non-book resources—what are the costs and effectiveness of different approaches to management, and what will be their impact on library resources?

As the information service moves towards becoming a communications facilitator a range of new skills and new demands will be required of information service personnel.

In this context we should perhaps look again at the important role of the "gatekeeper" model. What are the skills involved in this model and how do we transfer these skills to others so that they can become their own "gatekeeper." The gatekeeper becomes a facilitator of information within the organization. There is already some work going on in this area within the "gatekeeping Forum" under FID.

Research is required to determine what sort of measures would be appropriate in each context. For example we need ways of measuring the effectiveness of skills such as gatekeeping.

Learning new skills is not only a problem for library personnel but also for users and technicians. Online and CD-ROM introduce new problems for each of these groups.

There is the specific issue of training, and also the question of how this would be fitted into a research agenda. In other words, how would one formulate a research proposal in this area, or is it just something that one does? In fact it is probably the latter.

On the other hand, there is a need to study the most effective way of training professionals, particularly in new roles such as the "gatekeeping" mentioned earlier.

There is a need to look at what is already available in the training area, as applied to other professionals (engineers, medical staff, etc.) and to assess its applicability to the needs of information professionals.

Standards will also be important here. This applies not only to training standards, but training in the use of management standards in the context of things such as facilities management. On the one hand, detailed knowledge of technical standards requires considerable investment, while on the other, there may be intermediate positions where more general knowledge can be very effective.

"Performance standards" are the key concept here. Just as we are beginning to formulate performance standards for libraries, so too should we be looking at them for individuals. This is, in many respects, a tricky issue to face. What is probably needed is some way of assessing professional performance that can be openly perceived as rational, equitable and fair. It is not clear that we have any such measures at the moment.

Education and training are not quite the same thing, and we should perhaps take some care in differentiating between these (e.g., "training in the use of dialogue, education in the formulation of search strategies."

On this issue, it should be noted that promotion of the development of new professional roles is a high priority item within FID.

There is still a certain reluctance to discuss performance standards. Nevertheless, we must research how to develop performance standards that demonstrate, without any degree of vagueness, the value of our information services and libraries. In the final analysis, this is the only way we have of proving our value to the organization.

Quality management and quality control, as it is being applied in other areas of the organization, is equally applicable to library and information services.

If you are training people, then that is costing the organization money, and if you cannot demonstrate a return on this cost then you will not get the funding to continue with it.

If we are unable to give quality assurances at the level of our organization, then our clients may require more stringent assurances as to the quality of the product itself. In a way, this puts the requirement upon the users to establish criteria for the quality of the services they receive and may be a good thing.

Teasing out what is meant by performance measures, how to produce them, how to analyse them, is clearly a valid and important area of research.

On the problem of determining new methods for the indexing and cataloging of new media, such as video, it is not clear that our current methods are adequate. What research is needed to provide more effective, content based descriptors?

4. Application of the Technology

This section addresses the issue of using technology to provide better methods for indexing, encoding, storing and delivering information—making the connection

between the service level addressed in previous sections and the technology. Do libraries need systems analysts to get the technology together in a way in which the library can use it—who is there to advise them on what to buy and how to use it?

4.1 Analysis of the costs and benefits of bibliographic control, including different indexing and cataloging systems

4.2 Techniques for retrospective digitization of source documents

4.3 Novel encoding schemes for bibliographic and documentary data

4.4 The costs and benefits of network and other forms of alternative publishing

4.5 The role of the telecos, cable companies and other new players in the information marketplace

4.6 The role of technology standards

The perspective to be taken on this should be one of critical appreciation towards technology. From the information service point of view, there has possibly been too much passivity, too much uncritical acceptance of what the technologists have offered. There is therefore a need for research, first to develop appropriate measures for cost/benefit analysis of technology, and then to applying those measures in the evaluation of particular technologies or systems. In other words, are we getting value for money?

Discussion

There is a need to get the bibliographic record organized at the beginning of a research project, rather than after the whole thing has been completed. This could be of considerable help in project management, for example, by ensuring that appropriate information—such as funding details—would be included along with the bibliographic details.

Furthermore, bringing in the information center at this point should help reinforce its role in relationship to the --funding cycle (addressed in more detail later).

In many ways such information is already contained within the management information system. But this is completely apart from the information service or library. One question therefore is: should the information center be the place which provides this information; is its proper role to be at the hub of the organization, able to provide information in the appropriate form and at the right time to whoever needs it?

How can we move from industrial or defacto standards to open systems interconnection, so that different services can communicate with each other and orders or requests from a user can be passed to a library or information service in a standard format to make information available more easily than it is today. In other words, strategies for OSI migration are required and the elaboration of these may require research into the specific needs of information services in this regard.

Standards, the role of standards and the cost effectiveness of standards needs investigation. In particular, the role of library related standards such as ILL and SR. We need methods of technology assessment appropriate for the study of these protocol based systems.

Cost benefit analysis of the various bibliographic control methods is needed. There is also interest in newer methods of information retrieval, such as the vector approaches, as opposed to the boolean models. There are significant cost differences in the development of such systems and methodological analysis is required to assess these against the benefits.

There is also a need to consider the shift of interest in retrieval away from the conventional retrieval of document surrogates and towards that of other kinds of object (including multimedia, etc.).

5. Publication Analysis and the Role of the Information Service Within the Funding Cycle

This part of the model is concerned with the role that the information service might play within the quality assessment procedures of other parts of the organization, by utilizing their basic skills in areas such as bibliometrics.

It is also concerned with moves to "raise the profile" of the information service within the organization by focusing on user education and public awareness. Coupled with these is a concern for service cost analysis that should properly underly the performance measures discussed earlier.

5.1 Quality control, bibliometrics

5.2 Cost control of scholarly publishing

5.3 User education

5.4 Public awareness

5.5 Service cost analysis

Discussion

In considering the position of the information service within the hierarchy of the organization, it is important that its primary role be seen as that of information management—rather than just document management.

Alternative and novel forms of "bibliometrics" might also be considered as legitimate research possibilities. These might include the use of "acknowledgments" in Doctoral theses as a measure of performance value for academic supervisors (though validation might in this example prove rather difficult). Other examples that parallel conventional "citation" analysis might well be explored.

Closer to home, talking about cutting down on AGARD budgets suggests that a study on citation analysis of TIP publications could be a useful point of departure for work of this kind. There are, in fact, already some projects underway in this area.

Public awareness and the marketing of library services are issues which probably do not require research, but are simply things that need to be done—the requirements and strategies have been well-known for some time, and it is only our current mind-set that is inhibiting action.

6. Marketing New Services

Designing and implementing information systems that meet the needs of specific information-user constituents is the underlying objective of this section. It lies at the bottom of the model as being perhaps the most concrete and specific of the identifiable objectives.

6.1 Investigation into ways of using new technology to create new services

6.2 Trade policy for cross border information flow

6.3 Copyright control and revenue generation from network publishing

Discussion

What about the consideration of language issues in the development of ways of marketing information products

in different language areas—particularly as this is recognized as an important market development area within the European Community?

On marketing information services in general, it has been suggested that "We are pushing the wrong information to the wrong people in the wrong way. Test this hypothesis and make recommendations accordingly." This may simply be a rephrasing of the general question: What should information services be doing to market their services more effectively?

General Summary

The first section did not lead to any identifiable research topic, although suggestions and threads of ideas were beginning to appear that might eventually lead to some tangible model.

Within the general area of investigation of the changing role of the information service a number of specific subjects for study were suggested:

Concept analysis and the world of information

The way in which user behavior is already changing under the influence of technology

Problems in information service use: If we have intermediaries then the users don't use them, if we provide direct access then we have no control over the accuracy of their searches. This is a basic dichotomy that needs investigation.

Cost-effective measures of technology: It is undeniable that it is largely technology that is causing the change and we therefore need to know if it is cost-effective.

Changes in professional skills:

Research is needed into what measures of performance are appropriate for professional assessment

Training for use of new technologies and as "gate-keepers:" What are the most effective ways of training professionals for these new roles?

Establish performance standards. Standards and the delegation of tasks (e.g., facilities management)

Research into performance measures and use of same standards and methods as other groups within the organization

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THE AGARD TIP RESEARCH AGENDA FOR
SCIENTIFIC AND TECHNICAL INFORMATION (STI)

Walter R. Blados
NASA Scientific and Technical Information Office
Washington, DC
U.S.A.

Introduction

The Research Agenda contains three themes: Information Management, Provision of Information, and Access to Information. Provision of Information is further divided into two subordinate themes, Dissemination and Bibliographic Control; Access to Information is also further divided into two subordinate themes, Barriers and Equity and Networking.

Each theme or sub-theme was examined from four possible aspects, namely, Human Resources, Quality Assurance, Cost, and Technology. It was concluded that, in fact, a theme or sub-theme need not contain all four aspects. Graphically portrayed (see Table 5 of Chapter 3), the Research Agenda for Information Science will follow as outlined:

I. Information Management

- Human Resources
- Quality Assurance
- Cost
- Technology

II. Provision of Information

A. Dissemination

- Quality Assurance
- Cost

B. Bibliographic Control

- Quality Assurance

III. Access to Information

A. Barriers and Equity

- Human Resources
- Cost
- Technology

B. Networking

- Human Resources
- Technology

The following is a list of the themes, sub-themes, aspects, and topical areas; these form the Research Agenda.

I. Information Management

Human Resources

1. The extent to which training programs for the staff of libraries, information centers, and agencies result in better provision of access to information.

2. The extent to which performance measures for libraries and information centers can improve the quality and quantity of services provided to STI users.

3. Development, testing, and refinement of a user- access model that includes variables such as awareness, "organizational culture," "attitude toward information and communication technologies," one's own skill and level of training in retrieving information, relevance, quality, and financial resources.

4. Ability of libraries and information centers to provide their clientele with lesser-needed materials from remote storage and through inter-institutional lending.

5. Need for information specialists to act as information analysts.

6. The diffusion of information and how diffusions impacts the management and use of libraries and information centers.

7. Training information professionals to add value to information services.

8. Use of technical report literature and the implications of that use on collection development and management.

Quality Assurance

9. Service quality, or meeting clients' expectations, and the rising demands for information services in the environment of continual revenue shortages.

10. The application (or lack thereof) of the information life-cycle on STI, and refinement of the model as necessary.

11. The extent to which performance measures for libraries and information centers can improve the quality and quantity of services provided to STI users.

12. The extent to which libraries and information centers meet their mandated mission, goals, and objectives.

13. The skills and knowledge that information professionals will need to serve as change agents and ensure that current and planned services meet users's information needs and information seeking behavior.

Cost

14. Service quality, or meeting clients' expectations, and the rising demands for information services in the environment of continual revenue shortages.

15. Ability of libraries and information centers to provide their clientele with lesser-needed materials from remote storage and through inter-institutional lending.

16. The extent to which libraries and information centers meet their mandated mission, goals, and objectives.

17. Perceived versus actual barriers to information access (within libraries and information centers, for instance), and the extent to which physical layout of the library or information center impacts on access.

18. Determination of the "value" of information and marketing information services more effectively and efficiently.

19. The cost that libraries and information centers will have to absorb for making effective and efficient use of new technologies.

20. The necessity for libraries and information centers to cope with limited resources, while meeting their mission, goals, and objectives.

Technology

21. New methods of storage and dissemination, new systems for information and data access, and new methods of information resources management. For example, examine decision support systems, expert systems, graphic systems, and multimedia.

22. Standards for information and data interchangeability and use, and bringing the knowledge bases residing in many scattered reservoirs directly to uses. Examination of knowledge bases versus database, and the development and application of information technology standards.

23. The impact of new technologies on libraries and information centers, and the impact of user demands on libraries and information centers.

24. Investigation of knowledge diffusion within an electronic environment.

25. The role and impact of technology standards.

26. The use of new technologies to create new services.

II. Provision of Information

A. Dissemination

Quality Assurance

27. The impact of information overload on information access and use. Effective and efficient strategies for disseminating higher quality resources and for offsetting information overload, where a problem exists.

28. Analysis of government activities relating to quality control and information dissemination. How effective are these activities within a framework of information resources management?

Cost

29. New methods of storage and dissemination, new systems for information and data access, and new methods of information resources management. For example, examine decision support systems, expert systems, graphic systems, and multimedia.

30. The marketing of new information services and products within the context of information resources management and meeting the information needs of the public and target audiences.

B. Bibliographic Control

Quality Assurance

31. Levels of bibliographic control and the extent to which each level provides specific user groups with acceptable access to specific types of information.

32. Standards for information and data interchangeability and use, and bringing the knowledge bases residing in many scattered reservoirs directly to uses. Examination of knowledge bases versus database, and the development and application of information technology standards.

III. Access to Information

A. Barriers and Equity

Human Resources

33. Need for information specialists to act as information analysts and aid in meeting the information needs of the public, and in accomplishing the objectives of information resources management.

34. The extent to which performance measures for libraries and information centers can improve the quality and quantity of services provided to STI users.

35. The extent to which training programs for the staff of libraries, information centers, and agencies result in better provision of access to information.

Quality Assurance

36. Analysis of the barriers that inhibit access to high quality and needed information, and maintenance of the information life-cycle.

37. The information needs and information seeking behavior of scientists, engineers, and other groups, and their methods for coping with barriers and for finding the most relevant information.

38. Identification of nonusers of information services, and exploration of methods for conv······ these people into users.

Cost

39. The impact of the medium (type and format) in which knowledge, information, and data are presented on information access.

40. Access to information services in the workplace and the impact of spiraling costs and declining budgets on the ability of libraries and information centers to collect and provide access to information services on both a short-term and long-range basis. And, the impact of collection growth/stagnation on the information needs and information seeking behavior of library/information center clientele.

41. Development, testing, and refinement of a user-access model that includes variables such as awareness, "organizational culture," "attitude toward information and communication technologies," one's own skill and level of training in retrieving information, relevance, quality, and financial resources.

42. Equity of access to government/non-government information, seeing that those needing information receive it and know how to use it (this topical area includes the free versus fee debate).

43. Extent to which new information technologies are cost-effective and ensure access for people with varying backgrounds and levels of computer literacy.

44. "Access to electronic data and potential trends toward loss of information access by the economically underprivileged."

Technology

45. Availability of technology in the future that can read electronic information and data of today and yesterday. (The extent to which "information gaps" exist and information is unavailable to those entitled to its use.)

46. Software engineering and the integration of information.

47. Examination of gateways, their function, use and effectiveness.

48. The impact of networks and information-handling technologies on information access, and the extent to which telecommunciations infrastructures meet the needs for information access and transfer.

49. Man-machine interface and voice recognition, language processing, and user friendly interfaces.

B. Networking

Human Resources

50. Ability of libraries and information centers to provide their clientele with lesser-needed materials from remote storage and through inter-institutional lending.

Quality Assurance

51. Investigation of how researchers and others use networks to gather and filter information.

Technology

52. The impact of networks and information-handling technologies on information access, and the extent to which telecommunciations infrastructures meet the needs for information access and transfer.

53. High-speed computer networks and how they can facilitate users' access to networked information resources and satellite communications.

ADDITIONAL TOPIC AREAS MERITING INVESTIGATION

In the final or summary session of the Workshop, participants were asked to identify what they considered to be the single most important research topic. Their suggestions can be grouped under the topical areas of Human Resources, Quality Assurance, Cost, and Technology.

Three aspects of the 15 topical areas evoked considerable concern. These aspects include the value of information, treatment of information as a commodity, and user and staff education and training.

Libraries, information center, and other information providers are particularly concerned about coping with spiraling costs for resources and services, the need for improved information management, and meeting the information needs of clientele effectively and efficiently. There was interest in the development and introduction of performance measures that offer insights into the effectiveness and efficiency of library and information center programs, services, operations, and collections.

These, then, are what the Workshop attendees considered to be the most important research topics:

Human Resources

1. Investigate how users and non-users of libraries and information centers obtain information. Do their methods of information-seeking change over time, and are library and information staff aware of these methods? How, if at all, do information managers adapt their methods to provide information in a manner that will sell to these clients? How can actual non-users be identified and studied? These non-users must need access to information provided by the system.

2. Conduct information-seeking research within a conceptual framework that embraces the production, transfer, use, and management of information. That framework could be related to organizations (government/NATO), users (managers/staff), and type of environment (management/policy). One of the outcomes may be to identify the barriers that prohibit or restrict the use of information; another outcome may be to fund ways to improve the transfer of information among users.

3. Study the information acquisition process in the aeronautical and space field by chief executives and high level technicians.

4. The establishment of criteria/standards to measure the effectiveness of the library/information center as a strategic resource in a research organization.

5. Examine management of economic aspects due to decreasing budgets. Examine the efficiency of services, cost, market prices, and cost-effective management and control.

6. Examine improvements in communication between clients and multiple services, e.g., the introduction of OSI.

7. Create the feedback between users and database producers, hosts, and document supply centers.

8. Develop a dollar value on use of information in decision making or the R&D process.

9. Explore duplication of efforts within an organization and minimize such duplication where possible.

10. Profile information resource management within an organization, and show how to increase that profile.

Quality Assurance

11. Quality of information systems depends fully on the quality of information stored in databases and systems. Develop guidelines and standards on quality assurance of information transfer in aerospace and defense. Study the creation of technical reports within the NATO member nations.

Cost

12. Show that information is a commodity, one that is not free.

Technology

13. Identify the qualities needed (or expected) from information officers in relation to change resulting from the use of technology. What is expected from the perspective of training and education?

14. Study the use of PCs and networks, ad their influence on libraries and information centers.

15. Examine models other than those based on Boolean-Bascol logic, and the impact of new media on information retrieval models.

List of Participants

A Research Agenda for Scientific and Technical Information

Workshop held 7th—9th April, 1992 in Lisbon, Portugal.

Dr M.J. BARRULAS — L.N.E.T.I., C.I.T.I., Azinhaga dos Lameiros, 1699 Lisboa, Codex, Portugal

Mme H. BESTOUGEFF — 42 rue Pascal, Paris 75013, France

Mr C.J. BIGGER — Chief Librarian, GEC Marconi Research Centre, West Hanningfield Road, Great Baddow, Chelmsford, Essex CM2 8HN, United Kingdom

Mr W. BLADOS* — c/o NASA Scientific and Technical Information Program, NASA Headquarters, (Code JTT), Washington DC 20546, United States

Lt Col. H. BRAUN — DOKFIZBw, Dezernat DOK-Info, Friedrich-Ebert Allee 34, W-5300 Bonn 1, Germany

Mr J.W. BURCHELL — Assistant Director, The British Library, Research and Development Department, 2 Sheraton Street, London W1V 4BH, United Kingdom

Eng. J.A.T. de CASTRO — L.N.E.T.I., D.E.E., Azinhaga dos Lameiros, 1699 Lisboa, Codex, Portugal

Dr. rer. nat. C. von CONSBRUCH — Leiter der Zentralabteilung, Informationstechnik, Fachinformationszentrum Karlsruhe, W-7514, Eggenstein-Leopoldshafen 2, Germany

Dr Ing. A.M.R. CORREIA — L.N.E.T.I., Director, C.I.T.I., Azinhaga dos Lameiros, 1699 Lisboa, Codex, Portugal

Dr Z. CORREIA — L.N.E.T.I., C.I.T.I., Azinhaga dos Lameiros, 1699 Lisboa, Codex, Portugal

Ms G. COTTER — Director, NASA Scientific and Technical Information Program, NASA Headquarters, (Code JTT), Washington DC 20546, United States

Ms R. DEGNAN — Phillips Laboratory, OL/AC/PL/DO, Edwards AFC, CA 93523-5000, United States

Dr A. DEL REY — I.C.Y.T (CSIC), Head U.E.I. Information Retrieval, c/ Joaquin Costa 22, 28002 Madrid, Spain

Ms N. DIMOND — Phillips Laboratory (PL/XPG), Hanscom AFB, MA 01731-5000, United States

Dir. R.A. GJERSVIK — The Technical University Library of Norway, The University of Trondheim, Hogskoleringen 1, N-7034 Trondheim, Norway

Dr M.C. GUTIERREZ — INTA, Paseo Pintor Rosales 34, 28008 Madrid, Spain

Mr T.A. HERMANN — Head, Customer Service & Marketing, Scientific and Technical Information Facility, P.O. Box 8757, BWI Airport MD 21240, United States

Prof. P. HERNON* — Graduate School of Librarianship and Information Science, Simmons College, 300 The Fenway, Boston MA 02115, United States

Dr L. HILL — NASA Headquarters, Code JTT, Washington DC 20546, United States

Ir P.J. HOOGENBERK — Head of Scientific & Technical Documentation Centre of the Netherlands Armed Forces (TDCK), P.O. Box 90701, 2509 LS The Hague, The Netherlands

---

* Speaker

Mrs L.T.JARABEK	LeRC/NASA, Chief, Library Branch, Mail Code 60-3, 2100 Brookpark Road, Cleveland, OH 44135, United States
Mme F.LHULLIER	Chef du Service Documentation, ONERA, 29 Av. de la Division Leclerc, BP 72 — 92322 Châtillon Cedex, France
Mrs D.P.LOHNER	International Relations, Mission Information Scientifique et Technique, INSTN, CE SACLAY 91191 Gif/Yvette Cedex, France
Professor M.J.LYNCH	Department of Information Studies, The University of Sheffield, Western Bank, Sheffield S10 2TN, United Kingdom
Mrs I.MADER	ESA-IRS, ESRIN, Via Galileo Galilei, I-00044 Frascati, Italy
Mrs P.McWILLIAMS	HQ AFMC (I)/ENIS, Wright-Patterson AFB, OH 45433, United States
Ms A.OZDIL	Ministry of National Defence (MSB), Department of R&D (ARGE), 06550 Ankara, Turkey
Mrs D.PATRINOU	Technical Scientific Library, Hellenic Aerospace Industry, P.O. Box 23, GR 32009 Schimatari, Viotias, Greece
Mr B.J. PERRY	Director, R&D Department, British Library, Sheraton House, Sheraton Street, London W1V 4BH, United Kingdom
Dr T.PINELLI*	Assistant to the Chief, Research Information and Applications Division, NASA Langley Research Center, Hampton, VA 23665-5225, United States
Lt Col. J.G.RENY	NATO Terminology Coordinator, NATO/MAS, B-1110 Brussels, Belgium
Prof. Dr F.C.RODRIGUES	L.N.E.T.I., I.E.T.I., Azinhaga dos Lameiros, 1699 Lisboa, Codex, Portugal
Capt. Rui A.G.B.ROQUE	CDIFA, Base de Alfragide, Av. Leite de Vasconcelos, 2700 Amadora, Portugal
Mr R.P.RYAN	Deputy Administrator, Defense Technical Inf. Center, Cameron Station, Alexandria, VA 22304-6145, United States
Mr M.J.SCHRYER	Director, Directorate of Scientific Information Services, National Defence Headquarters, MGeneral George R. Pearkes Building, Ottawa, Ontario K1A 0K2, Canada
Cdt. J.STERKEN	Mobilisatiekern 29 — STAF, Steenbergestraat, 44, B-3380 Glabeek, Belgium
Mr G.STEVEN	Commission of European Communities, DG XIII-B, Batiment Jean Monnet, L-2920 Luxembourg
Dr K.A.STROETMANN	Gesellschaft für Mathematik und Datenverarbeitung MBH, PO Box 1316, D-W 5205 St. Augustin 1, Germany
Ir A.S.T.TAN	Information Specialist, National Aerospace Laboratory (NLR), P.O. Box 90502, 1006 BM Amsterdam, The Netherlands
Mr P.THORPE	Head, Scientific and Technical Information Department, SACLANT Undersea Research Centre, Viale San Bartolomeo 400, I-19138 La Spezia, Italy
Mr F.TSIMPOGLOU	Nat. Hellenic Research Foundation, Nat. Documentation Center, 48 Vas. Kostantinou Ave, 116 35 Athens, Greece
Dr W.TUCK*	Department of Computer Science, University College, Gower Street, London WC1E 6BT, United Kingdom
Dr N.TUNCER	Y.O.K. Dokumantasyon Merkezi, Hacettepe University, 06539 Bilkent/ Ankara, Turkey

* Speaker

M. E. VALENSI — Directeur, C.E.D.O.C.A.R., 00460 Armées, France

Dr A.C. VASCONCELOS — L.N.E.T.I., C.I.T.I., Azinhaga dos Lameiros, 1699 Lisboa, Codex, Portugal

Mr J. VILLAIN — Chef du Dépt. Information/Strategie, Société Européenne de Propulsion, 24 rue Salomon-de-Rothschild, BP 303, 92156 Suresnes Cedex, France

Mr W. WHALEN — Wright Laboratories, WL/DOOS, Wright Patterson AFB, OH 45433, United States

Mme C. WIEGANDT — Société Aérospatiale, 12 rue Pasteur — BP 76, 92152 Suresnes Cedex, France

Mr M.R.C. WILKINSON — Head, Defence Research Information Centre, Kentigern House, 65 Brown Street, Glasgow G2 8EX, United Kingdom

Prof I. WORMELL — Royal School of Librarianship, 6 Birketinget, DK-2300 Copenhagen S, Denmark

Mr A. YANEZ — Conseiller du Directeur, C.E.D.O.C.A.R., 00460 Armées, France

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14. Abstract

This Report presents the results of a workshop held by the Technical Information Panel of AGARD on 7th—9th April, 1992 in Lisbon, Portugal.

It includes three position papers on user needs, information access, and the organisation and transfer of information, prepared by the authors as a result of the discussions at the workshop. The outcome of the workshop, in the form of a 53-item research agenda, is given under the headings: information management; provision of information; and access to information. Each is examined from the aspects of human resources, quality assurance, cost, and technology, where appropriate.

The Report also includes a list of 15 additional areas meriting further investigation, which were identified by participants, during the final session of the workshop.

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NATO -⊕- OTAN

7 RUE ANCELLE · 92200 NEUILLY-SUR-SEINE

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